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AN ANALYTICAL STUDY OF HUMAN FACTOR IN MYANMAR AVIATION MAINTENANCE

NYEIN CHAN AUNG
EMPA - 43 (16th BATCH)

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AN ANALYTICAL STUDY OF HUMAN FACTOR IN MYANMAR AVIATION MAINTENANCE

A thesis submitted as a partial fulfillment of the requirements for the degree of Master of Public Administration (MPA)

Supervised by

Daw Soe Yu Hlaing
Lecturer
Department of Applied Economics
Yangon University of Economics

Submitted by

Nyein Chan Aung
Roll No. 43
EMPA 16th Batch
2017-2019

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ABSTRACT

Human being is intrinsically unreliable due the limitation performance of human physical design, thus occurring unintentional errors in aviation maintenance. Human factor is one of the safety barriers, that studying the interrelation of aviation crews' behaviors, machines, environment and the production process, which is used in order to prevent accidents or incidents of aircraft. This study is aim to identify the qualification of human factor and to express limitations of human factor in Myanmar Aviation Maintenance in order to be a safety barrier for Myanmar Aviation. A quantitative case study research design, descriptive method and survey with structured questionnaires are used to collect survey data from randomly selected 120 respondents. As per survey results ; Duties, responsibilities and good knowledge level is the strength of Myanmar Aviation Maintenance whilst the overall facilities implementation as per existing regulations is in medium range, also the limitations factors ,based on SHEL (Software, Hardware, Environment, Liveware), are still existing in Myanmar Aviation Maintenance. And monitoring and management programs for human factor are still not in perspicuous and still need to implement in practice more for protection of unintentional errors in aviation maintenance.

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LIST OF ABBREVIATION

AMEL	Aircraft Maintenance Engineer License
AML	Aircraft Maintenance License
AMO	Approved Maintenance Organization
ANO	Air Navigation Order
AOC	Air Operator Certificate
AWN	Airworthiness Notice
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CHIRP	Confidential Human Factors Incident Reporting Programme
CRM	Crew Resource Management
DCA	Department of Civil Aviation (Myanmar)
FAA	Federal Aviation Administration
FOD	Foreign Object Damage
HFAMI	Human Factors in Aviation Maintenance and Inspection
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMIS	Integrated Maintenance Information System
JAR	Joint Aviation Requirement
LAE	Licensed Aircraft Engineer
MCAR	Myanmar Civil Aviation Requirements
MEDA	Maintenance Engineering Decision Aid
MM	Maintenance Manual
MOE	Maintenance Organization Exposition
MORS	Mandatory Occurrence Report Scheme
MRM	Maintenance Resource Management
NTSB	National Transportation Safety Board
SDCPS	Safety Data Collection and Processing System
SHEL	Software, Hardware, Environment, Live-ware
SIR /SOR	Safety Improvement Report/ Safety Occurrence Report
SMS	Safety Management System

CHAPTER 1

INTRODUCTION

1.1 Rationale of the Study

Human factor is an unintentional error in the work scope which results in immediate damage of the system or it may be a hidden error which represents a potential danger for the airworthiness of the aircraft. At the same time, human error can be defined as the unintentional act of performing a task incorrectly which can potentially degrade the system by D. Virovac, A. Domitrović, E. Bazijanac in the "The Influence of Human Factor in Aircraft Maintenance,2016". Particularly, unintentional human errors in aircraft maintenance happen all the time while other factors such as weather, equipment and infrastructure were fitting. (IATA)International Air Transport Association statistics (1940) indicated that 80% of aviation accidents are due to human errors with 50% due to maintenance human factor problems. In 1926 and 1927 there were a total of 24 fatal commercial airline crashes, a further 16 in 1928, and 51 in 1929 (killing 61 people), which remains the worst year on record at an accident rate of about 1 for every 1,000,000 miles (1,600,000 km) flown. Based on the current numbers flying, this would equate to 7,000 fatal incidents per year.

Human Factor had been regarded as a branch of ergonometric for a long time and exclusively as portion of medical research. It is essential to investigate the interrelation of people, machines, environment and the production process. Thus, human is a major factor in the production and in operation process of technical means since it gives new value to the object of work. As a factor, the human is not perfect and introduces unintentional error in the system. It is crucial to develop a system of error identification and to work constantly on error prevention. Moreover, safety in aviation is a central a central issue for the industry since its early days, and all air transport operations are now built around a core concept of safe operations. Traditionally, humans were mostly blamed for most aircraft accidents and incidents, and many scholars have discussed the issue of human errors and the effects of human

behaviors and attitudes, especially dealing or interacting with an advanced technology such as aircraft systems.

The human factor's field tracks its origins to World War II and human performances in aviation industries are more intensity to scrutinize the effective management and lessen the adverse outcomes .The task and experience of scientists and engineers incorporated in human operations of systems, especially flight systems, with a focus on considering an operator's capabilities and limitations as they relate to the design of the system. Exponent's Human Factors scientists and engineers continue the tradition of applying knowledge of human capabilities and limitations to the performance of a wide range of activities within the aviation industry. Aviation industry operators and passengers interface in a cross-functional, complex, high-workload environment. Interaction with various systems and people, often under strict time constraints, is required and human performance can be a critical component to efficiency and safety. Human factors approaches, knowledge, and expertise can assist in the design and evaluation of such systems, and can result in a design more robust with respect to human performance.

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. Operations 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 aviation crews, an aviation human factor was born.

The use of the term human factors in the context of aviation maintenance engineering is relatively new. Aircraft accidents such as that to the Aloha aircraft in the USA in 1988 and the BAC 1-11 windscreen accident in the UK in June 1990brought the need to address human factors issues in this environment into sharp focus (NTSB 1989, AAIB (1992). The accident involving Aloha flight 243 in April 1988 involved 18 feet of the upper cabin structure suddenly being ripped away in flight due to structural failure. The Boeing 737involved in this accident had been examined, as required by US regulations, by two of the engineering inspectors. One inspector had 22 years' experience and the other, the chief inspector, had 33 years' experience. Neither found any cracks in their inspection. Post-accident analysis determined there were over 240 cracks in the skin of this aircraft at the time of the inspection. The ensuing investigation identified many human-factors-related problems

leading to the failed inspections. As a result of the Aloha accident, the US instigated a programme of research looking into the problems associated with human factors and aircraft maintenance, with particular emphasis upon inspection. The Human Factors in Aviation Maintenance and Inspection (HFAMI) web site lists 24 NTSB accident reports where maintenance human factors problems have been the cause or a major contributory factor.

Design and manufacturing, aircraft are becoming more and more reliable. However, it is not possible to re-design the human being: we have to accept the fact that the human being is intrinsically unreliable. However, Providing good training, procedures, tools, duplicate inspections, etc. can be working around with reliabilities. Also the potential for error by improving aircraft design such that, for example, it is physically impossible to reconnect something the wrong way, can be reduced.

This study was interested by consulting on human performances related factors contributing to Myanmar aviation concerns, both during the design process and following an incident or accident. Typical issues we address include: operational performance, warnings and alerting effectiveness, system usability, anthropometric considerations, and technical documentation interpretability.

Therefore, studying the interrelation of aviation crews behaviors, machines, environment and the production process becoming vital to help all personnel in the engineering maintenance environment (technicians, engineers, planners, managers, etc.) to recognize human performance limitations in themselves and others, and to be able to avoid, detect and rectify errors or error prone behavior and practices.

1.2 Objectives of the Study

The objectives of this study are to identify the qualification of human factor and to express limitations of human factor in Myanmar Aviation Maintenance.

1.3 Method of Study

A quantitative research design and descriptive method are used for this study. Survey with structured questionnaires, key formant interviews and focus group discussion are constructed to gather necessary information. Primary data are collected from a random sample of maintenance crews that selected from three maintenance organizations (domestic and international). The secondary data utilized in this study

are collected from are collected from Department of Civil Aviation's (DCA) library, literature books, research paper, various Human factor publications, and relevant issues from websites.

1.4 Scope and Limitations of the Study

This study is focused on the facilities of maintenance employees' human factor and how compliance can be affective to Myanmar Airlines, emphasized to maintenance organization, included such as maintenance personnel safety, procedures, tools, training, accommodation facilities, documentation, physical/mental concerns and working environment etc. Limited study to operating personals of other departments such pilots, GSE-Ground Support Equipment, Passenger Services departments etc.

Four sections of questionnaire with KAP formats compliment with monitoring and management of behavior, attitude, perception and limitations on tasks. From the AMO of airline operators, respondents were chosen from Myanmar Airways International (only International Airline), Myanmar National Airlines (Domestic and International Airline), and Air KBZ (only Domestic Airline).

1.5 Organization of the study

This thesis is organized into five chapters. Chapter one is the introduction, which describes the rationale, objectives, scope and limitations, method of study and organization of the study. Chapter two is Literature Review dealing Concept of Human Factor, Factors on Maintenance Personnel Performance, Types of Error in Maintenance Tasks, Implications of Errors (i.e. Accidents), Avoiding and Managing Errors. Chapter Three covers a study on AMC-Acceptable Means of Compliance-human factor's requirements based on SHEL model and mandated by MDCA (Myanmar Department of Civil Aviation) for AMO (Aircraft Maintenance Organization). Chapter Four looks into the data analysis and discussion. The analyzed data is presented in charts, bar graphs, tables in frequencies and percentages where applicable. Collected data is analyzed and discussion on the results initiated. Chapter Five entails Conclusion which includes findings and recommendation.

CHAPTER 2
LITERATURE REVIEW

2.1 Concept of Human Factor

There is a tendency among human beings towards complacency. The belief that an accident will never happen to me or to my Company can be a major problem when attempting to convince individuals or organizations of the need to look at human factors issues, recognize risks and to implement improvements, rather than merely to pay lip-service to human factors. Murphy's Law can be regarded as the notion: "If something can go wrong, it will."

If everyone could be persuaded to acknowledge Murphy's Law, this might help overcome the "it will never happen to me" belief that many people hold. It is not true that accidents only happen to people who are irresponsible or sloppy. The incidents and accidents show that errors can be made by experienced, well-respected individuals and accidents can occur in organizations previously thought to be safe. (Safety Action Group, 2002)

Human factors involves gathering information about human abilities, limitations, and other characteristics and applying it to tools, machines, systems, tasks, jobs, and environments to produce safe, comfortable, and effective human use. In aviation, human factors is dedicated to better understanding how humans can most safely and efficiently be integrated with the technology. That understanding is then translated into design, training, policies, or procedures to help humans perform better. Because improving human performance can help the industry reduce the commercial aviation accident rate, Aircraft Maintenance Engineering Human Factors for JAR 66 was issued by CAA-Civil Aviation Authority as Civil Aviation Publications; CAP-715, CAP-716, CAP-718, CAP-719 (Safety Action Group, 2002) documents are used not only for safe operation of aircraft, also in designed and production aircraft in accordance with ergonomics philosophies.

2.1.1 Human Factor Definition

Human factor refers to the study of human capabilities and limitations in the workplace. Human factors researchers study system performance. That is, they study

the interaction of maintenance personnel, the equipment they use, the written and verbal procedures and rules they follow, and the environmental conditions of any system. The aim of human factors is to optimize the relationship between maintenance personnel and systems with a view to improving safety, efficiency and well-being". (CAA, 2002)

Human factors include such attributes as; Human physiology, Psychology (including perception, cognition, memory, social interaction, error etc.), work place design, environmental conditions, Human-machine interface, anthropometrics (the scientific study of measurements of the human body).

A study was carried out in 1986, in the USA by SEARS (Safety Emergency Administrative Radio System), looking at significant accident causes in 93 aircraft accidents. Observed that maintenance deficiencies are directly involved causing the fatal accidents, whist other factors causing indirect accidents.

2.1.2 The SHEL Model

It can be helpful to use a model to aid in the understanding of human factors, or as a framework around which human factors issues can be structured. A model which is often used is the SHEL model, a name derived from the initial letters of its components:

(a) **Software**

Aviation maintenance's software are called the supported expositions and procedures that addresses for the associated work scope process and including the maintenance procedures, maintenance manuals, checklist layout, plans to each maintenance crews for all sorts of situation in maintenance conditions.

(b) **Hardware**

Maintenance hardware is the obvious equipment to support the completion of work scope and including the handling tools, test equipment, the physical structure of aircraft, design off light decks, positioning and operating sense of controls and instruments, etc.);

(c) **Environment**

Maintenance environment is the conditions which can impact to the maintenance crews while performing the associated work scope, obviously example of physical environment such as conditions in the hangar, conditions on the line and work environment such as work patterns, management structures, public perception of the industry, etc.

(d) **Liveware**

Maintenance liveware, so called maintenance crews, is the key player among SHEL model to perform the tasks in safety completion of work scope, including maintenance engineers, supervisors, planners, managers, etc.

2.2 Factors on Maintenance Personnel Performance

Influences which may lead to a person making errors or mistakes and these factors can be both internal and external, and include influences such as physical fitness, fatigue, stressors, noise, distraction, etc. There are also factors which may possibly be associated with violations, such as personality type, assertiveness, etc.

Factors potentially influencing performance include physical fitness, physiological characteristics such as visual acuity, color vision, hearing, personality, attitude, professional integrity, motivation, arousal level, low arousal (boredom), excessively high arousal (stress), stressors, alertness, fatigue, tiredness, shift work, sleep, circadian rhythms, distractibility, attention span, concentration, multi-tasking ability, situation awareness, information processing capability, memory, perception, intelligence knowledge level, awareness of knowledge level, experience, recency, cultural influences, company culture, national culture, norms.

2.2.1 Human Performance in Maintenance Engineering System

Just as certain mechanical components used in aircraft maintenance engineering have limitations, engineers themselves have certain capabilities and limitations that must be considered when looking at the maintenance engineering system. For instance, rivets used to attach aluminium skin to a fuselage can withstand forces that act to pull them apart. It is clear that that these rivets will eventually fail if enough force is applied to them. While the precise range of human capabilities and limitations might not be as well-defined as the performance range of mechanical or electrical components, the same principles apply in that human performance is likely to degrade and eventually fail under certain conditions (e.g. stress).

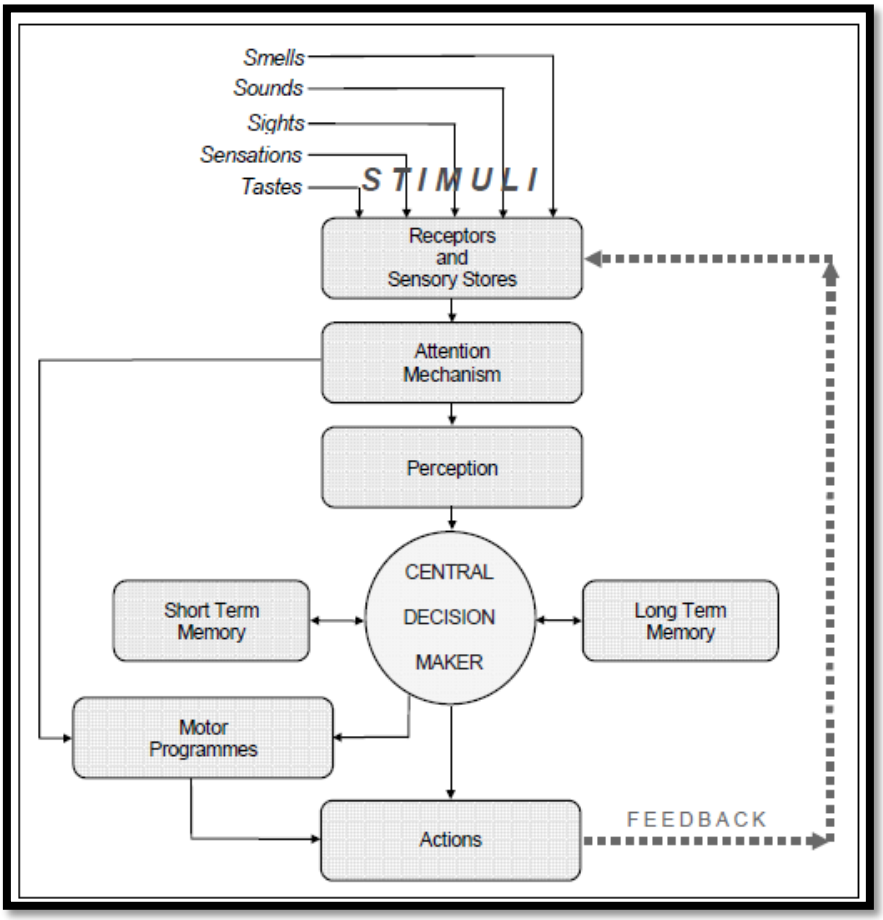
Mechanical components in aircraft can, on occasion, suffer catastrophic failures. Man, can also fail to function properly in certain situations. Physically, humans become fatigued, are affected by the cold, can break bones in workplace accidents, etc. Mentally, humans can make errors, have limited perceptual powers, can exhibit poor judgment due to lack of skills and knowledge, etc. In addition, unlike mechanical components, human performance is also affected by social and emotional

factors. Therefore failure by aircraft maintenance engineers can also be to the detriment of aircraft safety. The aircraft engineer is the central part of the aircraft maintenance system. It is therefore very useful to have an understanding of how various parts of his body and mental processes function and how performance limitations can influence his effectiveness at work. It is important for an engineer, particularly one who is involved in inspection tasks, to have adequate vision to meet the task requirements. As discussed previously, age and problems developing in the eye itself can gradually affect vision. Without regular vision testing, aircraft maintenance engineers may not notice that their vision is deteriorating.

2.2.2 Information Processing

Information processing is the process of receiving information through the senses analyzing it and making it meaningful. Information processing can be represented as a model**.** This captures the main elements of the process, from receipt of information via the senses, to outputs such as decision making and actions. One such model is shown in Figure 2.1.

Figure 2.1 A functional model of human information processing



Source: CAA, 2002

Various factors can affect and limit the visual acuity of the eye. These include: (i) Physical factors such as physical imperfections in one or both eyes (short sightedness, long sightedness), age. (ii) The influence of ingested foreign substances such as drugs, medication, alcohol, cigarettes. (iii) Environmental factors such as amount of light available, clarity of the air (e.g. dust, mist, rain, etc.). (iv) Factors associated with object being viewed such as size and contours of the object, contrast of the object with its surroundings, relative motion of the object, and distance of the object from the viewer, the angle of the object from the viewer.

Various factors can affect and limit the hearing. These include the performance of the ear is associated with the range of sounds that can be heard both in terms of the pitch (frequency) and the volume of the sound. The audible frequency range that a young person can hear is typically between 20 and 20,000 cycles per second (or Hertz), with greatest sensitivity at about 3000 Hz.

Noise can have various negative effects in the workplace. It can be annoying (e.g. sudden sounds, constant loud sound, etc.), interfere with verbal communication between individuals in the workplace, cause accidents by masking warning signals or messages, be fatiguing and affect concentration, decision making, damage workers' hearing (either temporarily or permanently). (Safety Action Group, 2002)

2.2.3 Limitations factors of maintenance personnel

The performance abilities and limitations of aircraft maintenance engineers have been described in 2.2.1. Other factors may also impinge on the engineer, potentially rendering him less able to carry out his work and attain the levels of safety required. These include fitness and health, stress, time pressures, workload, fatigue and the effects of medication, alcohol and drugs. (Safety Action Group, 2002)

(a) Fitness and health

The job of an aircraft maintenance engineer can be physically demanding. In addition, his work may have to be carried out in widely varying physical environments, including cramped spaces, extremes of temperature, etc. The ICAO requirements are enforced through the provision of Article 13 (paragraph 7) of the Air Navigation order (ANO). This states; "The holder of an aircraft maintenance engineer's license shall not exercise the privileges of such a license if he knows or suspects that his physical or mental condition renders him unfit to exercise such privileges."

(b) Stress

Stress can be defined as any force, that when applied to a system, causes some significant modification of its form, where forces can be physical, psychological or due to social pressures. Stress is usually something experienced due to the presence of some form of stressor, from these, we get acute stress (typically intense but of short duration) and chronic stress (frequent recurrence or of long duration) respectively; (i) **Domestic stress**- It typically results from major life changes at home, such as marriage, birth of a child, a son or daughter leaving home, bereavement of a close family member or friend, marital problems, or divorce.

(ii) **Work Related Stress -** Aircraft maintenance engineers can experience stress for two reasons at work, because of the task or job they are undertaking at that moment, or because of the general organizational environment. Stress can be felt when carrying out certain tasks that are particularly challenging or difficult. This stress can be increased by lack of guidance in this situation, or time pressures to complete the task or job. This type of stress can be reduced by careful management, good training, etc.

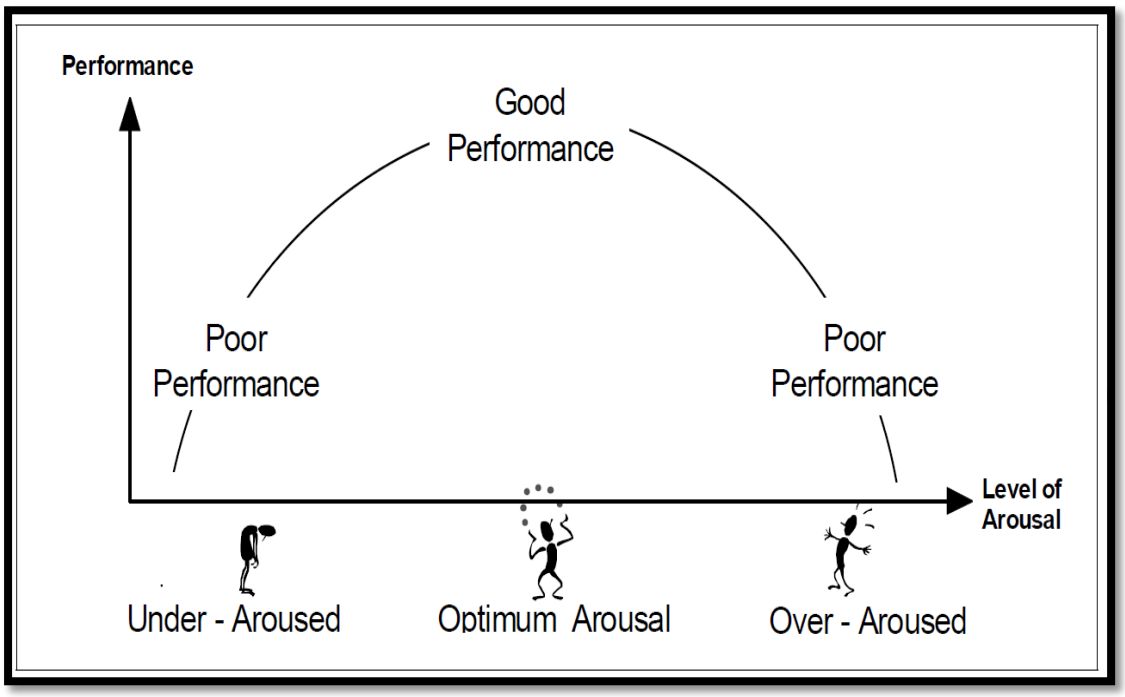
(c) Time pressure

There is probably no industry in the commercial Environment that does not impose some form of deadline, and consequently time pressure, on its employees. This might be actual pressure where clearly specified deadlines are imposed by an external source (e.g. management or supervisors) and passed on to engineers, or perceived where engineers feel that there are time pressures when carrying out tasks, even when no definitive deadlines have been set in stone. In addition, time pressure may be self-imposed, in which case engineers set themselves deadlines to complete work (e.g. completing a task before a break or before the end of a shift). Ultimately, these errors can lead to aircraft incidents and accidents. An extract from the NTSB report on the Aloha accident refers to time pressure as a possible contributory factor in the accident: "The majority of Aloha's maintenance was normally conducted only during the night. It was considered important that the airplanes be available again for the next day's flying schedule. Such aircraft utilization tends to drive the scheduling, and indeed, the completion of required maintenance work. Mechanics and inspectors are forced to perform under time pressure. Further, the intense effort to keep the airplanes flying may have been so strong that the maintenance personnel were reluctant to keep airplanes in the hangar any longer than absolutely necessary." (NTSB, 1988)

(d) Workload

The degree of stimulation exerted on an individual caused by a task is generally referred to as workload, and can be separated into physical workload and mental workload. We are also limited physically, in terms of visual acuity, strength, dexterity and so on. Thus, workload reflects the degree to which the demands of the work into our mental and physical capacities. Workload is subjective (i.e. experienced differently by different people) and is affected by; (i) The nature of the task, such as the physical demands it requires (e.g. strength required, etc.), mental demands it requires (e.g. complexity of decisions to be made, etc.). (ii) The circumstances under which the task is performed, such as the standard of performance required (i.e. degree of accuracy), time available to accomplish the task (and thus the speed at which the task must be carried out), requirement to carry out the task at the same time as doing something else, perceived control of the task (i.e. is it imposed by others or under your control, etc.) environmental factors existing at time (e.g. extremes of temperature, etc.). (iii) The person and his state, such as skills (both physical and mental) , experience particularly familiarity with the task in question, current health and fitness levels, emotional state. (e.g. stress level, mood, etc.).

Figure 2.2 Relation of Optimum arousal to best task performance

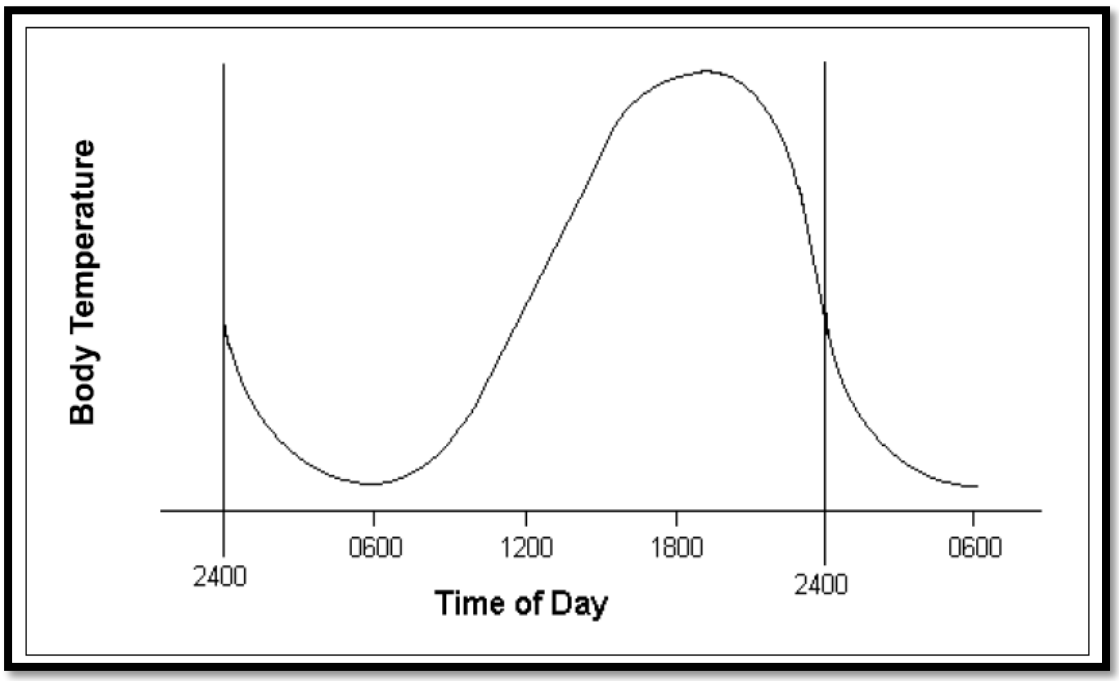


Source: Thom, 1999

(e) Sleep, Fatigue and Shift Work

Sleep is a natural state of reduced consciousness involving changes in body and brain physiology which is necessary to man to restore and replenish the body and brain. Apart from the alternation between wakefulness and sleep, man has other internal cycles, such as body temperature and hunger/eating. These are known as circadian rhythms as they are related to the length of the day. Circadian rhythms are physiological and behavioral functions and processes in the body that have a regular cycle of approximately a day (actually about 25 hours in man).The engineer's performance at this 'low point' will be improved if he is well rested, feeling well, highly motivated and well-practiced in the skills being used at that point. Although there are many contributory factors, it is noteworthy that a number of major incidents and accidents involving human error have either occurred or were initiated in the pre-dawn hours, when body temperature and performance capability are both at their lowest. Figure 2.3 shows the circadian rhythm for body temperature. Although there are many contributory factors, it is noteworthy that a number of major incidents and accidents involving human error have either occurred or were initiated in the pre-dawn hours, when body temperature and performance capability are both at the lowest.

Figure 2.3 The Circadian Rhythm for Internal Body Temperature



Source: JAR AMC 145, 1998

Fatigue can be either physiological or subjective. Physiological Fatigue reflects the body's need for replenishment and restoration. It is tied in with factors such as recent physical activity, current health, consumption of alcohol, and with circadian rhythms. It can only be satisfied by rest and eventually, a period of sleep. Fatigue is typically caused by delayed sleep, sleep loss, de-synchronization of normal circadian rhythms and concentrated periods of physical or mental stress or exertion. In the workplace, working long hours, working during normal sleep hours and working on rotating shift schedules all produce fatigue to some extent. Subjective fatigue is an individual's perception of how sleepy they feel. This is not only affected by when they last slept and how good the sleep was but other factors, such as degree of motivation. Shift work means that engineers will usually have to work at night, either permanently or as part of a rolling shift pattern. As discussed earlier in this chapter, this introduces the inherent possibility of increased human errors. Working nights can also lead to problems sleeping during the day, due to the interference of daylight and environmental noise. Blackout curtains and use of ear plugs can help, as well as avoidance of caffeine before sleep. In the B737 double engine oil loss incident, the error occurred during the night shift. The accident investigation report commented that: "It is under these circumstances that the fragility of the self-monitoring system is most exposed because the safety system can be jeopardized by poor judgment on the part of one person and it is also the time at which people are most likely to suffer impaired judgment". A good rule of thumb is that one hour of high-quality sleep is good for two hours of activity. Finally, it is worth noting that, although most engineers adapt to shift working, it becomes harder to work rotating shifts as one gets older.

(f) Alcohol, Medication and Drug Abuse

It should come as no surprise to the aircraft maintenance engineer that his performance will be affected by alcohol, medication or illicit drugs. As a general rule, aircraft maintenance engineers should not work for at least eight hours after drinking even small quantities of alcohol and increase this time if more has been drunk. Under both UK and JAA legislation it is an offence for safety critical personnel to carry out their duties whilst under the influence of alcohol or drugs. Article 13(paragraph 8) of the UK ANO, states: "The holder of an aircraft maintenance engineer's license shall not, when exercising the privileges of such a license, be under the influence of drinker a drug to such an extent as to impair his capacity to exercise such privileges."

Medication can be regarded as any over-the-counter or prescribed drug used for therapeutic purposes. Any medication, no matter how common, can possibly have direct effects or side effects that may impair an engineer's performance in the workplace. There is a risk that these effects can be amplified if an individual has a particular sensitivity to the medication or one of its ingredients. Hence, an aircraft maintenance engineer should be particularly careful when taking a medicine for the first time, and should ask his doctor whether any prescribed drug will affect his work performance. It is also wise with any medication to take the first dose at least 24 hours before any duty to ensure that it does not have any adverse effects.

Illicit drugs such as ecstasy, cocaine and heroin all affect the central nervous system and impair mental function. They are known to have significant effects upon performance and have no place within the aviation maintenance environment. Smoking cannabis can subtly impair performance for up to 24 hours. In particular, affects the ability to concentrate, retain information and make reasoned judgments, especially on difficult tasks.

(g) Physical Environment

The aircraft maintenance engineer can expect to work in a variety of different environments. This depends largely on the company he works for, and the function he fulfils in the company. Both physical environments have their own specific features or factors that may impinge on human performance. (i) Noise- Noise can be thought of as any unwanted sound, especially if it is loud, unpleasant and annoying. Noise in the workplace can have both short-term and long-term negative effects: it can be annoying, can interfere with verbal communication and mask warnings, and it can damage workers' hearing (either temporarily or permanently). It is very important that aircraft maintenance engineers remain aware of the extent of the noise around them. It is likely that some form of hearing protection should be carried with them at all times and, as a rule of thumb, used when remaining in an area where normal speech cannot be heard clearly at 2 meters. (ii) Fumes - The maintenance of aircraft involves working with a variety of fluids and chemical substances. For instance, engineers may come across various lubricants (oils and greases), hydraulic fluids, paints, cleaning compounds and solder. Fumes can cause problems for engineers mainly as a result of inhalation, but they can also cause other problems, such as eye irritation. It is also commonsense that if noxious fumes are detected, an engineer should immediately inform colleagues and supervisor so that the area can be evacuated and suitable steps

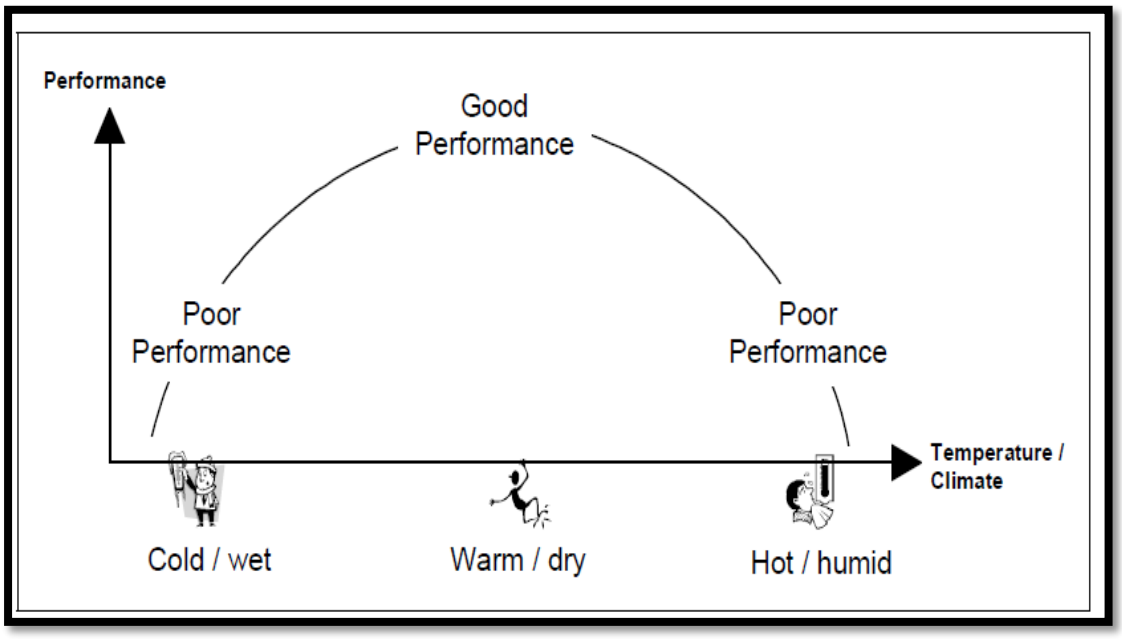
taken to investigate the source and remove them. (iii) Illumination - Illumination refers to the lighting both within the general working environment and also in the locality of the engineer and the task he is carrying out. At night, aerodromes may appear to be awash with floodlights and other aerodrome lighting, but these are unlikely to provide sufficient illumination for an engineer to be able to see what he is doing when working on an aircraft. Poor ambient illumination of work areas has been identified as a significant deficiency during the investigation of certain engineering incidents. It is equally important that lighting in ancillary areas, such as offices and stores, is good. Relying on touch when lighting is poor is no substitute for actually being able to see what you are doing. If necessary, tools such as mirrors and bore-scopes may be needed to help the engineer see into remote area. (iv) Climate and Temperature - Humans can work within quite a wide range of temperatures and climatic conditions, but performance is adversely affected at extremes of these. An engineer may have to work in direct summer sun, strong winds, heavy rain, high humidity, or in the depths of winter. Environmental conditions can affect physical performance. For example, cold conditions make numb fingers, reducing the engineer's ability to carry out fiddly repairs, and working in strong winds can be distracting, especially if having to work at height (e.g. on staging). Extreme environmental conditions may also be fatiguing, both physically and mentally. Engineers cannot be expected to maintain the rigorous standards expected in their profession in all environmental conditions. JAR145 Acceptable Means of Compliance (AMC) 145.25 (c) requires that environmental conditions be adequate for work to be carried out. Human performance is in optimal between the ambient temperature (18-25) Degree Celsius as shown in Table 2.1 and above and lower threshold limit can affect to human performance because the good performance of human beings depends on the warm/dry situation as per figure 2.4.

Table 2.1 Human performance at various temperatures.

Temp (C)	Performance Effect
32	Upper limit for performance
28	Maximum acceptable upper limit
25	Optimum with minimal clothing
21	Optimum for typical clothing and tasks
18	Optimum for winter clothing
15	Hand and finger dexterity begins to deteriorate
12	Hand dexterity reduced by 50%

Source: Gross, 1996

Figure 2.4 Relationship between climate, temperature and performance.



Source: JAR AMC 145, 1998

(v) Motion and Vibration - Aircraft maintenance engineers often make use of staging and mobile access platforms to reach various parts of an aircraft. As these get higher, they tend to become less stable. Any sensation of unsteadiness may distract an engineer, as he may concentrate more on keeping his balance than the task. Furthermore, it is vitally important that engineers use mobile access platforms properly in order to avoid serious injury. Vibration in aircraft maintenance engineering is usually associated with the use of rotating or percussive tools and ancillary equipment, such as generators. Low frequency noise, such as that associated

with aircraft engines, can also cause vibration. Vibration between 0.5 Hz to 20 Hz is most problematic, as the human body absorbs most of the vibratory energy in this range. (vi) Confined space- Working in any confined space, especially with limited means of entry or exit (e.g. fuel tanks) needs to be managed carefully. Engineers should ideally work with a colleague who would assist their ingress into and egress out of the confined space. Good illumination and ventilation within the confined space will reduce any feelings of discomfort. In addition, appropriate safety equipment, such as breath apparatus or lines must be used when required. (vii) Working Environment - Various factors that impinge upon the engineer's physical working environment and other physical influences include as per figure 2.5, i.e., Workplace layout and the cleanliness and general tidiness of the workplace (e.g. storage facilities for tools, manuals and information, a means of checking that all tools have been retrieved from the aircraft, etc.);The proper provision and use of safety equipment andsignage (such as non-slip surfaces, safety harnesses, etc.; The storage and use of toxic chemical and fluids (as distinct from fumes) (e.g. avoiding confusion between similar looking canisters and containers by clear labeling or storage in different locations, etc.).

To some extent, some or all of the factors associated with the engineer's work place may affect his ability to work safely and efficiently. JAR 145.25 (c) – Facility Requirements states: The working environment must be appropriate for the task carried out and in particular special requirements observed. Unless otherwise dictated by the particular task environment, the working environment must be such that the effectiveness of personnel is not impaired. Working environments of maintenance normally comprises with social, physical and tasks. Social environments include individual and team responsibility, motivation, culture, management, supervision, leadership etc. Physical environment is the factors affecting to work scope including noise, illumination, fumes, climate, temperature, motion, confined space, workplace layout, cleanliness etc. Tasks meaning the physical and repetitive for the associated work scope in maintenance to be accomplished.

(h) Communication

Communication is defined in the Penguin Dictionary of Psychology as: "The transmission of something from one location to another. The 'thing' that is transmitted may be a message, a signal, a meaning, etc. In order to have communication both the transmitter and the receiver must share a common code, so

that the meaning or information contained in the message may be interpreted without error". Good communication is important in every industry. In aircraft Maintenance engineering, it is vital. Communication, or more often a breakdown in communication, is often cited as a contributor to aviation incidents and accidents. Aircraft maintenance engineers often work as teams. Individuals within teams exchange information and need to receive instructions, guidance, etc. Moreover, one team will have to pass on tasks to another team at shift handover. An engineer needs a good understanding of the various processes of communication, as without this, it is impossible to appreciate how communication can go wrong. Communication can be; Verbal/spoken (e.g. a single word, a phrase or sentence, a grunt), Written/textual (e.g. printed words and/or numbers on paper or on a screen, hand written notes), Non-verbal communication **((**Graphic - e.g. pictures, diagrams, hand drawn sketches, indications on a cockpit instrument), (Symbolic - e.g. 'thumbs up', wave of the hand, nod of the head), (Body language - e.g. facial expressions, touch such as a patois, posture))

There are two main ways in which communication can cause problems. These are lack of communication and poor communication**.** The former is characterized by the engineer who forgets to pass on pertinent information to a colleague, or when a written message is mislaid. The latter is typified by the engineer who does not make it clear what he needs to know and consequently receives inappropriate information, or a written report in barely legible handwriting. Both problems can lead to subsequent human error. Basic rules of thumb to help aircraft maintenance engineers minimize poor communication are; think about what you want to say before speaking or writing, speak or write clearly, listen or read carefully, seek clarification wherever necessary.

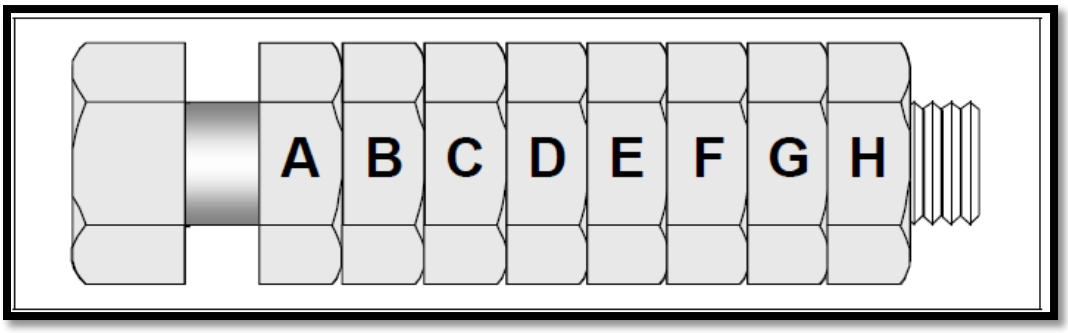
2.3 Types of Error in Maintenance Tasks

Any maintenance task performed on an aircraft is an opportunity for human error to be introduced. Errors in aircraft maintenance engineering tend to take two specific forms; An error that results in a specific aircraft problem that was not there before maintenance task was initiated, i.e. incorrect installation of line replaceable units, an error that results in an unwanted or unsafe condition remaining undetected while performing a maintenance task designed to detect aircraft problems, i.e. a

structural crack unnoticed during a visual inspection task or faulty avionics box that remains on the aircraft.

Reason analyzed the reports of 122 maintenance incidents occurring within a major airline over a 3 year period. Identified the main causes as being; Omissions (56%), incorrect installation (30%), Wrong parts (8%), other (6%). It is likely that Reason's findings are representative for the aircraft maintenance industry as a whole. Omissions can occur for a variety of reason, such as forgetting, deviation from a procedure (accidental or deliberate), or due to distraction. The B7372 double engine oil loss incident, in which the HP rotor drive covers were not refitted is an example of omission. Incorrect installation is unsurprising, as there is usually only one way in which something can be taken apart but many possible ways in which it can be reassembled. Reason illustrates this with a simple example of a bolt and several nuts (see Figure 2.6), asking the questions (a) how many ways can this be disassembled? (the answer being 1) and (b) how many ways can it be reassembled?(the answer being about 40,000, excluding errors of omission!). (Reason J. , 1997)

Figure 2.5 Reason's Bolt and Nuts Example



Source: Reason, 1997

2.3.1 Individual Practices and Habits

Where procedures allow some leeway, aircraft maintenance engineers often develop their own strategies or preferred way of carrying out a task. Often, a 'good' rule or principle is one that has been used successfully in the past. These good rules become rules of thumb that an engineer might adopt for day-to-day use. Problems occur when the rule or principle is wrongly applied. For example, aircraft pipe couplings are normally right hand threads but applying this 'normally good rule' to an oxygen pipe (having a different thread) could result in damage to the pipe. Also, there can be dangers in applying rules based on previous experience if, for example, design

philosophy differs, as in the case of Airbus and Boeing. This may have been a factor in an A320 locked spoiler incident, where subtle differences between the operation of the spoilers on the A320 and those of the B767 (with which the engineers were more familiar) meant that actions which would have been appropriate on the B767 were inappropriate in the case of the A320. In addition, engineers may pick up some 'bad rules', leading to bad habits during their working life, as a driver does after passing his driving test. An example of applying a bad rule is the British Rail technician in the Clapham train accident who had acquired the practice of bending back old wires rather than cutting them off and insulating them.

2.3.2 Visual Inspection

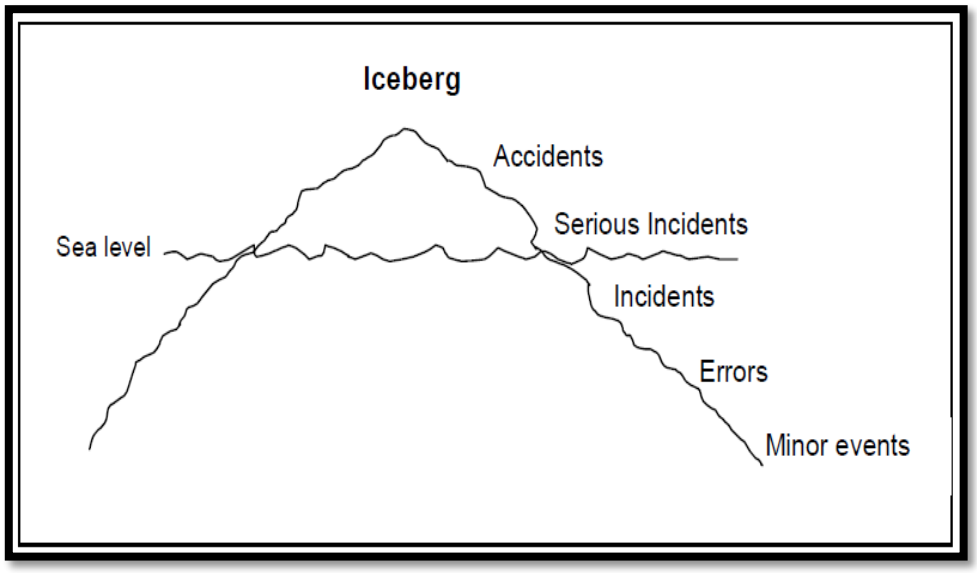
There are also two particular types of error which are referred to particularly in the context of visual inspection, namely Type 1 errors and Type 2 errors. A Type 1 error occurs when a good item is incorrectly identified as faulty; a Type 2 error occurs when a faulty item is missed. Type 1 errors are not a safety concern per se, except that it means that resources are not being used most effectively, time being wasted on further investigation of items which are not genuine faults. Type 2 errors are of most concern since, if the fault (such as a crack) remains undetected, it can have serious consequences (as was the case in the Aloha accident, where cracks remained undetected).

2.4 Implications of Errors

In the worst cases, human errors in aviation maintenance can and do cause aircraft accidents. However, as portrayed in Figure 2.7, accidents are the observable manifestations of error. Like an iceberg which has most of its mass beneath the water line, the majority of errors do not result in actual accidents. Errors that do not cause accidents but still cause a problem are known as incidents. It is vital that aircraft maintenance engineers learn from their own errors and from the errors made by others in the industry. These powerful and persuasive lessons are the positive aspects of human error. When an error occurs in the maintenance system of an airline, the engineer who last worked on the aircraft is usually considered to be 'at fault'. The engineer may be reprimanded, given remedial training or simply told not to make the same error again. However, blame does not necessarily act as a positive force in aircraft maintenance: it can discourage engineers from 'coming clean' about their errors. They may cover up a mistake or not report an incident. It may also be unfair to

blame the engineer if the error results from a failure or weakness inherent in the system which the engineer has accidentally discovered (for example, a latent failure such as a poor procedure drawn up by an aircraft manufacturer - possibly an exceptional violation).

Figure 2.6 Iceberg Model

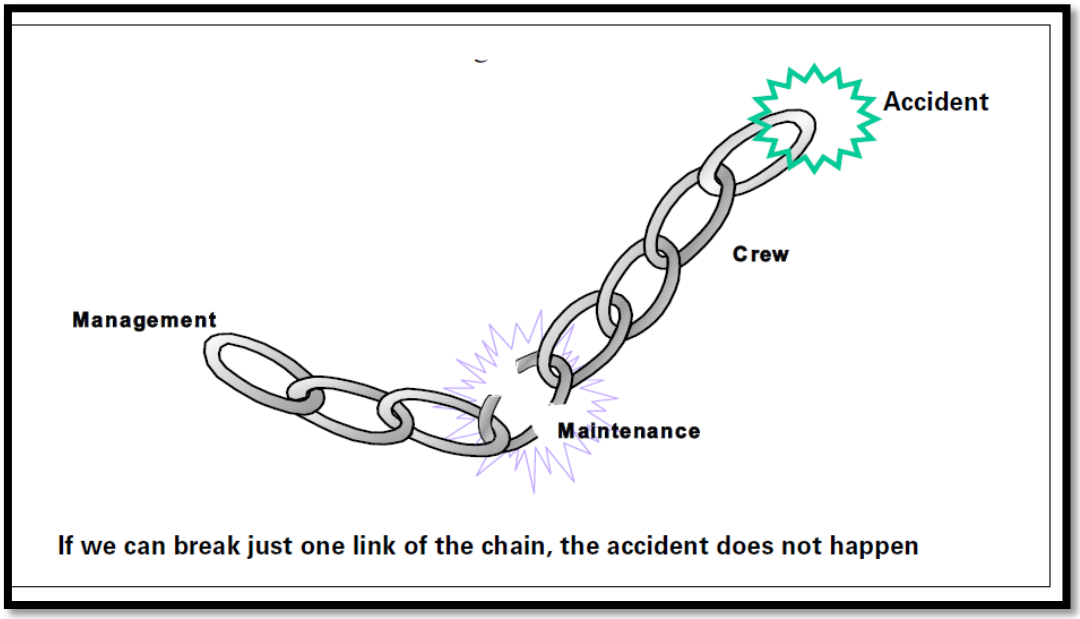


Source: AAIB Report, 1992

2.5 Avoiding and Managing Errors

Whilst the aircraft maintenance engineering industry should always strive towards ensuring that errors do not occur in the first place, it will never be possible to eradicate them totally. Therefore all maintenance organizations should aim to 'manage' errors. Error management seeks to: prevent errors from occurring, eliminate or mitigate the bad effects of errors. To prevent errors from occurring, it is necessary to predict where they are most likely to occur and then to put in place preventative measures. Such incident reporting schemes do this for the industry as a whole. The accident or incident was preventable and could have been avoided if any one of a number of things had been done differently. As with many incidents and accidents, all the examples above involved a series of human factors problems which formed an error chain in figure2.8, If any one of the links in this 'chain' had been broken by building in measures which may have prevented a problem at one or more of these stages, these incidents may have been prevented. Maintenance is at central part of error chain to break the chain preventing the accidents. (Boeing, 1993)

Figure 2.7 Error Chain



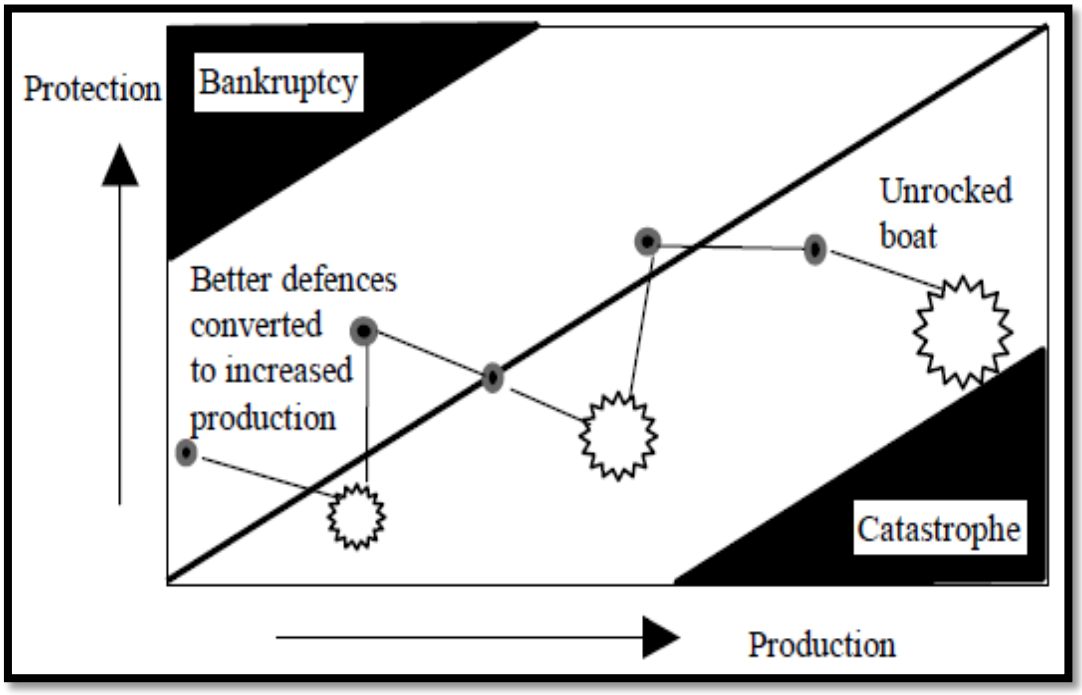
Source: Boeing, 1993

Within a maintenance organization, data on errors, incidents and accidents should be captured with a Safety Management System (SMS), which should provide mechanisms for identifying potential weak spots and error-prone activities or situations. Output from this should guide local training, company procedures, the introduction of new defenses, or the modification of existing defenses. One of the things likely to be most effective in preventing error is to make sure that engineers follow procedures. This can be affected by ensuring that the procedures are correct and usable, that the means of presentation of the information is user friendly and appropriate to the task and context, that engineers are encouraged to follow procedures and not to cut corners. According to Reason, error management includes measure to Minimize the error liability of the individual or the team; Reduce the error vulnerability of particular tasks or task elements; Discover, assess and then eliminate error-producing (and violation- producing)factors within the workplace; Diagnose organizational factors that create error-producing factors within the individual, the team, the task or the workplace, enhance error detection; Increase the error tolerance of the workplace or system; Make latent conditions more visible to those who operate and manage the system; Improve the organization's intrinsic resistance to human fallibility.

Ultimately, maintenance organizations have to compromise between implementing measures to prevent, reduce or detect errors, and making a profit. Some

measures cost little (such as renewing light bulbs in the hangar); others cost a lot (such as employing extra staff to spread workload). Incidents tend to result in short term error mitigation measures but if an organization has no incidents for a long time (or has them but does not know about them or appreciate their significance), there is a danger of complacency setting in and cost reduction strategies eroding the defenses against error. Reason1 refers to this as "the un-rocked boat" (Figure2.9). It is important that organizations balance profit and costs, and try to ensure that the defenses which are put in place are the most cost-effective in terms of trapping errors and preventing catastrophic outcomes.

Figure 2.8 Lifespan of a hypothetical organization



Source: Reason, 1997

It is important that organizations balance profit and costs, and try to ensure that the defenses which are put in place are the most cost-effective in terms of trapping errors and preventing catastrophic outcomes. Ultimately, it is the responsibility of each and every aircraft maintenance engineer to take every possible care in his work and be vigilant for error On the whole, aircraft maintenance engineers are very conscious of the importance of their work and typically expend considerable effort to prevent injuries, prevent damage, and to keep the aircraft they work on safe. (Reason J. , 1997)

2.6 Review on previous Studies

A research paper; The Influence of Human Factor in Aircraft Maintenance, by Darko Viorvac, Dr. Anita Domitrovic and Dr. Ernest Bazijanac from University of Zagreb-Croatia, is the main support to be a systematic approach of thesis and the trace of how to explore the Myanmar Aviation Maintenance's limitations and qualifications. The study emphasized to express how human factor influence the aviation maintenance and the impact of human error in maintenance organization and the ways to mitigate the human errors.

Hein Zaw Moe (2018), who conducted a thesis "A Study on airworthiness requirements of Myanmar Aviation Industries" analyzed the standard of airworthiness in Aviation Maintenance. The detail expression of international civil regulations and functions of Myanmar DCA bring to perspicuous understanding of Human Factor's role in establishment of standard airworthiness system in Myanmar Aviation. The study was also supported how to analyze the limitations on maintenance and assess the qualifications of human factor in Myanmar Aviation.

Another survey conducted by San Linn (2019) who explored a thesis in "Analysis on Improvement of Airport Service after Liberalization in Aviation Industry of Myanmar" explored the service liberalization in Myanmar Airports focused to airlines' services to passengers. The paper had emphasized on the passengers' awareness in Yangon International Airports concerning the services of Airlines. The thesis support how to prepare of questionnaire for assessment of facilities and limitations in maintenance department of airlines.

CHAPTER 3

OVERVIEW ON MYANMAR AVIATION MAINTENANCE

3.1 History of Myanmar Aviation

The British Overseas Airways Corporation (BOAC) was the very first government association for carrying out all of civil aviation functions in Myanmar. Union of Burma Airways (UBA) was founded by the government after independence on 15 September 1948, which initially operated only domestic services, then limited international services to neighboring destinations were expanded in 1950. Myanmar became a member state of the ICAO on 8 August 1948 with a view for the systematic development of international civil aviation when after signing the Chicago Convention at Chicago on 4 April 1947 and the International Civil Aviation Organization (ICAO) was established as worldwide safety management.

Air transport is involved in vital role to support the economy of Myanmar. The tourism and cargo transport sector are significantly growing in Myanmar aviation sector Myanmar National Airlines, the national carrier, is among the airlines (in the region) with extensive route network in Asia, ensuring their dominant position in providing essential regional air transport services. Also MAI (Myanmar Airways International) recently provides serving 6-destinations in south-east Asian countries, adding 5 routes to China and India.

Myanmar Aviation regulation System was based on the CAA-UK (Civil Aviation Authority-United Kingdom) on the passed days and is now following to updated regulations which are mandated by EASA (European Aviation Safety Agency), in order to promote and harmonize Myanmar aviation to international Airworthiness management standard. The requirements for AMO (Aircraft Maintenance Organization) and Air Operator are based on the EASA Requirements and address to standardize the International aviation capabilities, preparing in line with the Standard and Recommended Practices of ICAO Annex 1, Annex 8.

Recently, there are 39 airfields in Myanmar and 35 airports are used as commercial purpose, which airports handling for international flights are Yangon International Airport, Mandalay International airport and Nay Pyi Taw International Airport. The Airlines operated in our nation and the historical background of the airlines is shown in appendix table 3.1.

3.2 Legislation and Regulations Framework in Myanmar

Myanmar Civil Aviation followed EASA rules for safety control in maintenance including human factor management and also standardized ICAO annexes 1-19 as per contracting state. Maintenance personnel in Myanmar aviation maintenance field are about 600 employees. Human factor management frame work is conducted as per regulations;

(a) Myanmar Aircraft Act 1934

Myanmar aircraft Act was mandated for the purpose of to make better provision for the control of manufacturer, possession, use, operation, sale, import and export of the aircraft in Myanmar. It intended to make the safe operation and protect the public health. Thus, expressed; power of the president to make rules for protecting public health (paragraph 8A, 8B), Power of the President of the Union to make orders in emergency (paragraph 6(1), (2), (3),(4)), Penalty for act in contravention of rule made under this Act (paragraph 10,11,12) etc.

(b) Myanmar Aircraft Rules 1937

Union of Myanmar Aircraft Rules, 1937, expressed the acceptable rules to apply all aircraft for the time being in or over the Union of Myanmar, provided that aircraft registered elsewhere than in the Union of Myanmar, relating to registration, licensing of personnel, airworthiness and log books there shall be substituted the regulations of the State in which the aircraft is registered, operation of aircraft in safely, penalty for rules contravention to make sure in safe operation of aircraft in Myanmar.

(c) MCAR Part 1 (Air operator certificate)

Myanmar DCA (Department of Civil Aviation issued the MCAR part-1(2013), for the operator whom operate the aircraft for remuneration or hire , which clearly defined regulations in the Part address the standards in ICAO Annex 18 and the air operator requirements of ICAO Annex 6, Parts I and III which included regulations concerning the AOC certificate, flight operations management, maintenance requirements, security management, and dangerous goods management and shipping.

(d) MCAR Part 66 (Aircraft Maintenance License)

MCAR part-66 (2011), prescribes the requirements governing the issue of aircraft maintenance licenses and the privileges, limitations and recent experience of those licenses, intended to have a qualified liveware in maintenance for issuing CRS (Certificate of Release to Service).

(e) MCAR Part 145 (Approved Maintenance Organization)

MCAR part 145 (2013) specifies the conditions to be met by the organization involved in Maintenance of Myanmar Registered Aircraft. Addressing the acceptable means of compliance in establishing AMO (Approved Maintenance Organization) based on SHEL model (Software, Liveware, Hardware, Environment) and quality system for make sure of safety operation.

(f) MCAR Part 147 (Approved Maintenance Training Organization)

MCAR part 147 (2011) specifies the conditions to be met by the organization which involved in Aviation Maintenance Training for Liveware personnel.

(g) CAP715

CAP715 "An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66" is introduced at 2002 by Safety Action Group, CAA(Civil Aviation Authority) that intended to provide an introduction to human factors and human performance and limitations for ab-initio engineers studying for their JAR-66 engineering licenses, addressing human factors in maintenance from an organizational perspective, within maintenance organization.

(h) CAP716

CAP 716 "Aviation Maintenance Human Factors" published by Safety Action Group, CAA at 2002 specifies "Guidance Material on the UK CAA Interpretation of Part-145Human Factors and Error Management Requirements".

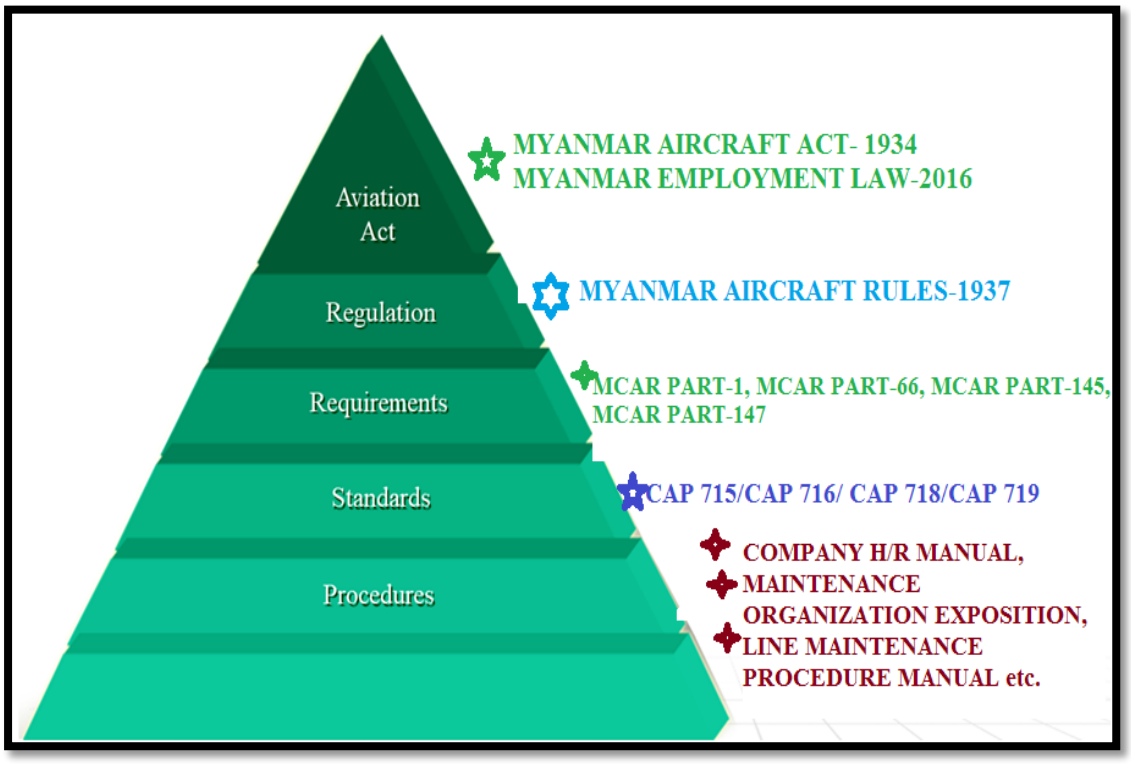
(i) CAP 718

CAP 718 "Human Factors in Aircraft Maintenance and Inspection" 2002 also published by CAA and describes ; Human Error in Aircraft Maintenance and Inspection, Human Factors Issues Affecting Aircraft Maintenance, Teams and Organizational Issues in Aircraft Maintenance, Automation and Advanced Technology Systems, Error Prevention Considerations and Strategies etc.

(j) CAP 719

CAP 719-Fundamental Human Factors Concepts,2002 referred to ICAO Digest.1 and specifies ;The Industry Need for Human Factors, Human Factors Applications in Flight Operations, Education and Expertise etc.

Fig 3.1 Applications of Human Factor In Myanmar Aviation



Source: MDCA, 2018

3.3 Requirements of Human factor in Myanmar Aviation

Myanmar Airlines has to be adopted the mandated laws, MCAR requirements, and regulations approved by Myanmar DCA and QA-Quality Assurance Department of each company. Typical implementations in airlines for mitigating the undesired consequences of insufficient human factor supplements as per conceptual SHEL model;

(a) Software

Instruction procedures, check lists and updated manuals have to be fulfilled for make sure of airworthiness instruction and procedures such Level -1 Documents MOE (Maintenance Organization Exposition and CAME (Continuous Airworthiness

Maintenance Exposition) in which listed the duties, responsibilities, procedures for each work scopes and function, shall to be submitted to Authority and approval only if in standardization of AMC (Acceptable Means of Compliance), Myanmar DCA as per MCAR part 145. Also Level-2 Documents for each maintenance departments such LMPM (Line Maintenance Procedure Manual), ESM (Engineering Services Manual), SPM(Store Procedure Manual) etc. shall be written, approved and apply for ensuring in correct procedures. Also updated maintenance data (maintenance manuals, procedures, checklist etc.) shall be applied in Aircraft Maintenance Organization as per MCAR part-1 and 145, 2013.

(b) Live-ware

Qualifications Requirements for Aircraft maintenance personnel are mandated in MCAR part-66 as per ICAO annex-1 (personnel licensing) such sufficient staff shall have for each work scope of which at least staff perform maintenance in each workshop, that hangar or flight line on any shift should be employed to ensure the organizational stability. In order to make sure the certifying staff qualifications, certifying staff must be eligible for the grant of an aircraft maintenance license(MCAR 66.2.1.3**),** at least 21 years of age, have a diploma and/or an academic degree in technical discipline, from University and Institution recognized by Union of Myanmar, have passed written examination, including an examination in Air Law, are acceptable to the DCA; and relevant to the duties and responsibilities of an aircraft maintenance in the category of license sought; and an oral examination covering the person's understanding and practical application of the duties and responsibilities exercised by the holder of an aircraft maintenance license. The person signing maintenance release or an approval for return to service shall be qualified in appropriate Licensing system to the work performed and shall be acceptable to the DCA (MCAR 145).

Employee's rights and responsibilities have to be mandated in HR-manual of each company 8 hours/working day and on leaves. Rest and duty limitations for airlines employees performing maintenance functions on AOC (Air Operator) aircrafts shall be in accordance with MCAR-1(1.4.1.3) such; No person may assign, nor shall any person perform maintenance functions for aircraft certified for commercial air transport, unless that person has had a minimum rest period of 8 hours prior to the beginning of duty, No person may schedule a person performing maintenance functions for aircraft certified for commercial air transport for more than

12 consecutive hours of duty, In situations involving unscheduled aircraft un-serviceability, persons performing maintenance functions for aircraft certified for commercial air transport may be continued on duty for Up to 16 consecutive hours; or 20 hours in 24 consecutive hours. Following unscheduled duty periods, the person performing maintenance functions for aircraft shall have a mandatory rest period of 10 hours; The AOC holder shall relieve the person performing maintenance functions from all duties for 24 consecutive hours during any 7consecutive day period. Appropriate trainings for each maintenance employee shall be provided such; Company Procedures, Human Factor, EWIS-Electrical Wiring Interconnecting System, Fuel Tank Safety etc. and such trainings in recurrent interval. (MCAR-145, 2013).

(c) Hard-ware

Facility requirements in accordance with MCAR part 145145.3.1.3such as: The AMO shall have available the necessary equipment, tools, and material to perform the approved scope of work and these items shall be under full control of the AMO, Shall use the equipment, tools, and material that are recommended by the manufacturer of the article or must be at least equivalent to those recommended by the manufacturer and acceptable to the DCA, The AMO shall keep all records of calibrations and the standards used for calibration.

(d) Environmental

Environmental facility requirements in accordance with human performance are indicated in MCAR 451, sub part 145.25 Facility Requirements such; Sufficiency of hangar space to carry out planned base maintenance, relative to the maintenance programmed, Protection from the weather elements, should prevent the ingress of rain, hail, ice, snow, wind and dust etc., Aircraft maintenance staff should be provided with an area where they may study maintenance instructions and complete maintenance records in a proper manner. The staff should have sufficient room to carry out the assigned tasks, MCAR Part 145 AMO shall have a maintenance man-hour plan showing that the organization has sufficient staff to plan, perform, supervise, inspect and quality monitor the organization in accordance with the approval, The necessary expertise related to the job function, competence must include an understanding of the application of human factors and human performance issues appropriate to that person's function in the organization, Storage facilities shall be provided for parts, equipment, tools, and material as per MCAR145, 2013.

(e) Quality System Requirements

As per MCAR part-1 quality of maintenance organization shall be audited by QA (Quality Assurance) manager in accordance with existing mandated regulation and finding has to be corrected to make sure a safe operation of the aircraft. Stating as; Each AOC holder shall establish a quality system and designate a quality manager to monitor compliance with, and adequacy of procedures required to ensure safe operational practices and airworthy aircraft. Compliance monitoring shall include a feedback system to the accountable manager to ensure corrective action as necessary, Each AOC holder shall ensure that the quality system includes a quality assurance programme that contains procedures designed to verify that all operations are being conducted in accordance with all applicable requirements, standards and procedures. (MCAR part-1, 2013**)**

3.4 Accidents and Fatalities in Myanmar Aviation

Myanmar has experienced quite a number of occurrences, accidents, incidents happened in all forms of transportation such as inland-river, off rain of trains, numerous road accidents and aircraft crashes all claiming thousands of lives. All these have not resulted in a properly well thought of national airworthiness regulation. Although the best regulations have been passed, there may be such kinds of incidents when there is no enforcement. It is natural that there are defaults how regulations and human factor are the best. People damaged by aircraft crashes are rarer than by shark bite. In the following table, it is illustrated the number of occurrences, accidents and incidents data from 2010 to 2018.

Table 3.1 Accidents and Fatalities rate in Myanmar (2008-2018)

Interval	Aircraft Type / Operator	Accident	Fatalities	Remark
2008-2009	1. ATR72(XY-AIE), Air Bagan 2. Fokker 28(XY-ADW),Myanmar Airways	2	___	Scheduled commercial flight on airplane above 5.7 Tons
2010-2011	___	___	___	
2012-2013	1. Fokker-100 (XY-AGC), Air Bagan 2. MA-60 (XY-AIQ), Myanmar Airways	2	2	
2014-2017	1. Airbus A320(XY-AGT), GMA 2. Airbus A319(XY-AGR), MAI	2	___	
2017-2019	1. Embraer E190(XY-AGQ), MNA	1	___	

Source: Aviation Safety network, 2019

Review to statistics of accidents in Myanmar as per Aviation Safety network, 2019, found highest accident in 2012-2013 periods with fatalities due human performance limitations as per table 3.1. Accidents rate is highest in 2008-2009, 2014-2017 and 2017-2019 in moderate accident and 2010-2011is no accidents years as shown in table 3.1. And recent accident in 2019, due nose landing gear extension failures of MNA (Myanmar National Airlines) with no fatalities.

The Number of occurrence, incident and serious incident including human factor management failures are collected from Myanmar DCA. Occurrence in aircraft is the facts delaying the operation or AOG (Aircraft on Ground) condition due defects of aircraft systems (Engine, Flight control, Fire on aircraft etc.) and reported by operator, incident in aircraft is the consequences of human error such using wrong procedures, improper tools etc. Serious incidents are the facts impairing the airworthiness of the aircraft, damage and injury or death occurring. The following table 3.2 shows that the number of occurrence, incident and serious incident including human factor management failures (2010-2018).

Table 3.2 Number of occurrence, incident and serious incidents (2010-2018)

Airline	Occurrence	Incidents	Serious Incidents
Myanmar National Airline	20	82	20
Myanmar Airways International	6	16	4
Air Bagan	14	12	11
Air KBZ	4	40	4
Asian Wings	-	3	2
Air Mandalay	1	7	10
Golden Myanmar Airlines	-	4	2
Yangon Airways	2	16	3
Mann Yadanarpon Airlines	-	4	1
Total	47	184	57

Source: Myanmar Accident Investigation Bureau (MAIB), 2018

Table 3.1 indicates that accidents, incidents and occurrences which are collected from nine Airlines and occurrences rate. MNA (Myanmar National Airlines) got the highest occurrences, incidents, serious incidents rate among Myanmar Airlines

with highest operation, also Air Bagan and Air KBZ occurred the high rate occurrence and incidents. And Mann Yadanapon Airlines, Asian Wings was in the lowest rate while in lower operation routes compared with others. GMA airlines got no occurrences during (2010-2018) but incidents are occurred respectively. Obviously found that the rate of occurrence, incidents is directly proportional with the numbers of routes operation whilst MNA (Myanmar national Airlines), MAI (Myanmar Airways International) are in high operation rate. Thus, higher operation in airlines making stress and pressure to maintenance personnel, error rate due maintenance will be high, so human factor and safety management system should be practiced for make sure optimal human factor and to mitigate the management failures.

3.5 Safety Management System (SMS)

Safety Management System is a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. Safety management systems manual (SMSM) is to communicate its approach to the management of safety throughout the organization. In accordance with MCAR part-1 (Air Operator Certificate), an AOC holder shall establish and maintain a safety management system. The AOC's holder shall implement a safety management system acceptable to the DCA that as a minimum.

Figure 3.2 Typical SMS (Safety Management System)

Source: Vistair, 2009

The main four tasks of safety management as per figure 3.4; Identifies safety hazards (Data collection the potential hazards such from Reports(SIR-Safety Improvement and SOR-Safety Occurrence Report)) and audits findings, Ensures the implementation of remedial action necessary to maintain agreed safety performance (finding the ways how to mitigate ,reduction the hazards to avoid the accidents), Provides for continuous monitoring and regular assessment of the safety performance, Aims at a continuous improvement of the overall performance of the safety management system.

CHAPTER 4
SURVEY ANALYSIS

4.1 Survey Profile

There are nine Airlines operating in Myanmar and their AMO-Approved Maintenance Organizations are recently based at Yangon International Airport. Each maintenance department for each Airline is mainly comprised with Quality Assurance Department, Line Maintenance Department, Engineering Services Department and Materials and Logistics Department. Two Airlines named MNA (Myanmar National Airlines) and MAI (Myanmar Airways International) is the international carrier and other seven Airlines are operating as domestic, among them MNA(Myanmar National Airlines) and KBZ (Air Kanbawza) are operating widely the most routes in Myanmar.

There are about 600 maintenance employees in Myanmar Aviation and most of them are employed at MNA (Myanmar National Airlines) and offices of maintenance departments are based at Yangon International Airport.

Among the nine Airlines, MNA (Myanmar National Airlines) is also certified to carry out MRO-Maintenance Repair Organization tasks by EASA-European Aviation Safety Agency) at 2018, whilst the other Airlines' maintenance are still in line maintenance capabilities for their aircrafts.

4.2 Survey Design

The study employed various sampling techniques to select 120 respondents from respective airlines who constituted AMOs that are directly involved with airline operations from which Quality Assurance Department, Line Maintenance Department, Engineering Services Department and Materials and Logistics Department.

Determination of the sample size selected for this study was due to the cost-effective reasons, considering the figure of 120 respondents from the AMO of airline operators, respondents were chosen from Myanmar Airways International (only International Airline), Myanmar National Airlines (Domestic and International Airline), Air KBZ(only Domestic Airline) at Yangon International Airport.

Four sections of questionnaire with KAP formats compliment with monitoring and management of behavior, attitude, perception and limitations on tasks. They were requested and assisted to fill a pre-structured questionnaire. Participation was done individual level to maintain confidentiality. Introductions to the respondents were made to get it easier to administer the questionnaire. The environment was made to contribute to the participants when they are informed that the study was purely academic. The data were collected over a period of 7 days.

The survey involves the determination of relationship between an explanatory variable (the employee-human factor) and a response variable (response capacity of Maintenance Organizations). Questionnaires (structure and unstructured), based on "SHEL model" (interrelation of maintenance crews behaviors, machines, environment and the production process), has been used in data collection. While questionnaires have been given out for the 120 responders to fill, the information gathered key informant supplemented the data from questionnaires and provided additional perspective on understanding employee's facilities requirement of MDCA and existing procedure manuals.

4.3 Survey results

To achieve the identified aim and objectives of this study, an extensive study was carried out at three airlines in Myanmar. Survey findings therefore present the characteristics of respondents, knowledge and information concerning human factor, compliance of requirements (Software, Hardware, Liveware, and Environment), facilitation implementation. The analyzed data is presented tables in frequencies and percentages where applicable.

4.3.1 Characteristics of Respondents

In this part, information on the basic characteristics of the respondents was presented with gender, age, educational level, work experience, types of air lines and their working departments. The specific characteristics of these respondents are presented in the presentations and discussions that follow.

Table 4.1 Demographic Characteristics of Respondents

Statements	Category	No. of Respondents	Percentage
Gender	Male Female	110 10	91.7 8.3
	Total	**120**	**100**
Age	21-30 31-40 41-50 Above 50	28 68 15 9	23 57 12.5 7.5
	Total	**120**	**100**
Educational Level	Engineering Post Engineering Other Graduates	93 6 21	77.5 5 17.5
	Total	**120**	**100**
Work Experiences	1-5 years 6-10 years 11-15 years 16-20 years More than 20 years	39 46 11 15 9	32.5 38.38 9.16 12.5 7.5
	Total	**120**	**100**
Air lines	International Domestic Both	34 30 56	28.3 25 46.7
	Total	**120**	**100**
Departments	Quality Assurance Line Maintenance Engineering Service Materials and Logistics	8 86 16 10	6.67 71.7 13.33 8.3
	Total	**120**	**100**

Source: Survey Data, 2019

According to table (4.1), with the gender base issue the majority 110 (91.7%) is male respondents and only 10 (8.3%) female respondents participated in this study

because of the nature of job. Among 120 respondents, 5.7 percent of the respondents are above 50 years old and 12.5 percent of the respondents are 41-50 years old. The rest 23percent and 57 percent of the respondents are young group and aged between 21and 40 years old. According to the survey data, most of the respondents (77.5%) hold engineering degree, 5 percent of respondents were educated to post graduate engineering and other (17.5%) graduated from the different fields, indicates that the study was dealing with well-educated respondents. Regarding the experiences in aviation maintenance, 46(38.38%) gained 6-10 years in maintenance field which is the majority group, follow by 39(32.5%) employees whom gotten 1-5 years experiences, 15(12.5%) employees in (16-20) years experiences, 11(9.16%) employees in (11-15) years and 9(7.5%) employees in highest experiences(more than 20 years) are the least in aviation maintenance respectively. This indicates that most of respondents have the required experiences involving in aviation maintenance practices. Among of respondents, 56(46.7%) respondents are maintaining the Domestic and International operating aircrafts, 34 (28.3%)respondents maintained for International operating aircraft, and 30(25%) respondents are from Domestic operating Airlines, showing that the study is supported by the respondents whom got the differ nature from each others in aviation maintenance field. Overall 71.7% of respondents were from line maintenance department which is the highest percentage. About 13.3% were from Engineering service department and 11.67% from engineering service department whilst 8.3% were from materials and logistics department. Only 6.67%were from quality assurance department which is the least, proving that most of survey data collected from the frontier personnel who are included in series at Error Chain philosophy (Boeing, 1993).

4.3.2 Human Factor Knowledge and Information level

Well understanding the knowledge and information concerning human factor requirements mandated in Myanmar DCA (Department of Civil Aviation) and Aircraft Maintenance Engineering Human Factors' knowledge is essential to maintenance employees to support the safety concerns and also in collecting the effective survey data.

Table 4.2 Knowledge and Information level of Human Factor

Statements	level	No. of Respondents	Percentage
Knowing their duty and responsibilities involved in MOE	Yes No Not sure	120 - -	100 - -
	Total	**120**	**100**
Human Factor training as per DCA requirement	Yes No Not sure	120 - -	100 - -
	Total	**120**	**100**
Regulatory training for each department concerning with human factor as per MCAR	Yes No Not sure	120 - -	100 - -
	Total	**120**	**100**
Organization have the update and recurrent training plan	Yes No Not sure	120 - -	100 - -
	Total	**120**	**100**
Getting information concerns with human factor requirements from MDAC	Yes No Not sure	117 - 3	97.5 - 2.5
	Total	**120**	**100**
Level of compliance with human factor implications	Very well well Well Neutral Not well	53 52 15 -	44.17 43.33 12.50 -
	Total	**120**	**100**

Source: Survey Data, 2019

Table 4.2 shows that, all employees at maintenance organizations know their duties and responsibilities as per existing exposition of their Airlines, and well understand the training for Human Factor is in regular basis as per Myanmar DCA requirements.

Also the human factor Information level as per existing Myanmar DCA requirements, all respondents understand why the regulatory training for human factor. And most of respondents up to 95% know the training interval information whilst 5% of respondents reported that the training held every 1 year interval. Also the information level for human factor requirements as per MCARs are high, as 97.5% of respondents reported saying "Yes", whilst 2.5% respondents say "Not Sure". That result proves that the survey data are responded by maintenance employees whom got high knowledge and information level in their field.

4.3.3 Departmental Role in safety

In aviation Maintenance, comprising with four departments in which Line Maintenance is in frontier performing maintenance at aircraft in touch while Engineering Services is monitoring and control the airworthiness and Material and Logistics supports the necessary items in accordance with airworthiness requirements. Among them, Quality Assurance audits and controls other departments to make sure in airworthiness situation. Therefore, knowing well of each departmental role in fulfillment of their associated tasks to make sure in safety situation is needed to assess the safety level.

Table 4.3 Departmental Role in Airlines for Safety

Department in reduction of human error in aircrafts	Number of respondents	Percentage
Primarily responsible for forming all airworthiness requirement and procedure with minimal input from other department	69	57.5
Airworthiness requirement and procedures with equal input from other department	45	37.5
Advises other departments that are primarily responsible for forming airworthiness requirement and procedure	6	5
No role in airworthiness requirement	-	-
Total	**120**	**100**

Source: Survey Data, 2019

As shown in Table 4.3, the majority of respondents 57.5% reported that their department is primarily responsible for forming all airworthiness requirement and procedures with minimal input from other department. 37.5% of respondents expressed their department formed airworthiness requirement and procedures with

equal input from other departments. And 5%respondents showed that other departments were primarily responsible for forming airworthiness procedures. Proving that 95% of respondents very well understand that the safety concerns depend upon their associated tasks and only a few 5% respondents still in need to understand that every their tasks can impact the aircraft safety.

4.3.4 Level of compliance with Human Factor implications

Human factor requirements in accordance with existing regulations should be complied in aviation maintenance field. Thus, perception of employees is important to express the compliance level of requirements.

Table 4.4 Level of compliance with Human Factor implications

Level of compliance	Number of respondents	Percentage
Very well	53	44.17
Well	52	43.33
Neutral	15	12.50
Not well	-	-
Not at all	-	-
Total	**120**	**100**

Source: Survey Data, 2019

Table 4.4 compares the respondents' perception concerning with their organizations' compliance with human factor's requirement. Overall, respondents perceive their organizations to be better prepared for human factor. Most respondents believed that their organizations are very well compliance 44.17% or well 43.33%. About 12.50% expressed they do not want to answer about this. That result shows that most of airlines prepared fairly the requirements of human factor in general as per existing requirements but a few still need to implement through a perfect implications leading way to lack of accidents.

4.4 Overall Facilities

Facilities implemented in each airline will differ as per their financial concerns. However, the overall facilities should be well supported to the employees' abilities in accordance with their associated maintenance work scope in order not to impact the safety of the aircraft. Thus, overall facilities can also assess the practice of

maintenance nature depending how well airlines prepared for employees without impairing their abilities.

Table 4.5 Implementations of Facilities by Maintenance Organizations

Requirement for Human Factor (AMO)	Very well prepared (5)	Well prepared (4)	Neutral (3)	Not well prepared (2)	Not at all prepared (1)	Mean
Housing, offices Facility Requirements	33 (27.5%)	45 (37.5%)	42 (35%)	-	-	3.925
Personnel Requirements	44 (36.7%)	59 (49.2%)	5 (4.2%)	2 (1.7%)	-	3.96
Equipment Tools and Material Requirements	14 (11.7%)	64 (53%)	27 (22.5%)	12 (10%)	3 (2.5%)	3.62
Certifying Staff and Category B1 and B2 Support Staff Requirement	55 (45.8%)	62 (51.7%)	3 (2.5%)	-	-	4.43
Acceptance of Components Requirement	41 (34.1%)	55 (45.8%)	24 (20%)	-	-	4.14
Maintenance Data Requirement	53 (44.25%)	67 (55.8%)	-	-	-	4.44
Production Planning Requirement	49 (40.8%)	71 (59.2%)	-	-	-	4.41
Certification of Maintenance Requirement	43 (35.8%)	77 (64.2%)	-	-	-	4.36
Maintenance Records Requirement	46 (38.3%)	74 (61.7%)	-	-	-	4.38
Occurrence Reporting Requirement	33 (27.5%)	68 (56.7%)	9 (7.5%)	-	-	3.87
Safety, Training, Quality Policy, Maintenance Procedures and Quality System Requirement	28 (23.3%)	65 (54.2%)	27 (22.5%)	-	-	4
Overall Mean Score						3.8

Source: Survey Data, 2019

Table 4.6 Interpretation of Mean Score

Mean Score	The Level of Agreement
0.00 – 1.5	Very Low
1.51 – 2.50	Low
2.51 – 3.50	Moderate
3.51 - 4.50	High
4.51 – 5.00	Very High

Source: Moidunny, 2009

As observed in Table 4.5, all kinds of response regarding the Overall Facilities Implementations of Maintenance Organizations. Obviously shown that the facilities implementations are in very well and well prepared (87.43%), (11.4%) of respondents answered in neutral and (1.17%) not agree AMO are prepared for good facilities implementations. That results overall mean score (3.8) can be interpreted as of well prepared in most of airlines for employees to support their abilities for their associated work scope, but a few facilities such Housing and offices Facility, Equipment Tools and Material Requirements still need to compliment for more safety maintenance without impairing the employees' abilities.

4.5 Limitations to Employees' abilities

Knowing the limitations to aviation maintenance field can mitigate the impending danger to aviation safety by fulfilling the necessaries. Therefore, SHEL (Software, Hardware, Environment, Liveware) Model is used to explore the obstacles of the maintenance work scope. Detailed expression of limitations as per survey data are listed in Table (4.6, 4.7, 4.8) as follows.

Table 4.7 Software Limitations

Software for Human Factor (AMO)	Very well prepared (5)	Well prepared (4)	Neutral (3)	Not well prepared (2)	Not at all prepared (1)	Mean
Computer Based Manuals and updated Data for easy access	46 (38.3%)	45 (37.5%)	5 (4.2%)	4 (3.3%)	-	3.6
Updated Check Lists and Perspicuous procedures for each maintenance tasks	33 (27.5%)	68 (56.7%)	9 (7.5%)	-	-	3.87
Communication Links between each Crews, Shifts, Department	28 (23.3%)	65 (54.2%)	27 (22.5%)	-	-	4
Shift Organization structure (Shift Pattern, Rest and Duty Limitations etc.)	15 (12.5%)	64 (53.3%)	12 (10%)	9 (7.5%)	-	3.2
Individual reporting procedure for safety concerns (including SIR and SOR)	33 (27.5%)	74 (61.7%)	9 (7.5%)	4 (3.3%)	-	4.1
Overall Mean Score						3.8

Source: Survey Data, 2019

Table 4.6 indicates a software limitation of the respondents, how they have prepared or not well prepared. Showing that many organizations well prepare their best to meet the requirements (86.9%) responded very well and well prepared while a few does not prepare enough due (10.3%) in neutral and (2.8%) in disagree of good software implementations in Airlines. Obviously found that Communication Links between each Crews/Shifts/Department, Shift Organization structure, Individual reporting procedure for safety concerns, Computer Based Manuals and updated Data for easy access, Updated Check Lists and Perspicuous procedures are still needed to implement for more mitigation of software limitations. Overall mean score (3.8) obviously shown that software facilities is at high level in most of airlines.

Table 4.8 Hardware and Environmental Limitations

Hard ware and Environmental for Human Factor (AMO)	Very well prepared (5)	Well prepared (4)	Neutral (3)	Not well prepared (2)	Not at all prepared (1)	Mean
Aircraft Handling for each systems	11 (9.17%)	53 (44.17%)	44 (36.7%)	12 (10%)	-	3.5
Safety Equipment (Ear/Eye protection etc.)	13 (10.83%)	65 (54.17%)	42 (35%)	-	-	3.8
Transportation, communication support equipment	22 (18.33%)	68 (56.67%)	30 (25%)	-	-	3.9
Sufficient Calibrated tools and Equipment	14 (11.67%)	89 (74.17%)	17 (14.2%)	-	-	3.9
Health support facilities (clinic, medical box, Hospital)	21 (17.5%)	73 (60.83%)	26 (21.7%)	-	-	3.9
Proper working places creation (Suitable Housing, allocation, Hangar, office, rest-room etc.)	31 (25.83%)	79 (65.83%)	10 (8.34%)	-	-	4.2
Overall Mean Score						3.9

Source: Survey Data, 2019

Table 4.7 gives a Hardware and Environmental of the respondents occurring in Myanmar Aviation Maintenance, Found most of organization well prepare their best to meet the requirements while a few does not prepare enough. Observed that 23.4% is in neutral response and 1.7% is in unsatisfactory perception on facilities, showing still need to implement the suitable hardware facilities and workplaces for employees. The result of overall mean score (3.9) show that Hard ware and Environmental facilities are well prepared in most of airlines.

Table 4.9 Live-ware Limitations

Live ware for Human Factor (AMO)	Very well prepared (5)	Well prepared (4)	Neutral (3)	Not well prepared (2)	Not at all prepared (1)	Mean
Updated recurrent Trainings	10 (8.34%)	80 (66.66%)	29 (24.16%)	1 (0.83%)	-	3.8
Personnel Skills Training for each work scope	18 (15%)	78 (65%)	23 (19.16%)	1 (0.83%)	-	3.9
Preventions to Dirty dozens	19 (15.83%)	68 (56.67%)	33 (27.5%)	-	-	3.9
Human Resources Allocations (Efficient Employees for each Department and work scope)	11 (9.17%)	62 (51.67%)	47 (39.16%)	-	-	3.7
Human Resources Management Plan for employee	15 (12.5%)	75 (62.5%)	25 (20.83%)	5 (4.17%)	-	3.8
Overall Mean Score						3.8

Source: Survey Data, 2019

As expressed in Table 4.8, all kinds of response are observed regarding the live- ware Facilities Implementations of Maintenance Organizations. The response to each question varies along with the experiences and recent situations of each employee. 26% respondents in neutral perception and 7(1.17%) employees are in unsatisfactory situation to Hardware and Environmental implementations of Airlines for maintenance employees, proving that still in need to implement. Liveware's facilities implementation is at high level as the result of overall mean score (3.8).

Table 4.10 Monitoring for Employees' human factor

Statement	Response	No of Respondents	Percentage
Fair Duty Limitations	Yes	95	79.2
	No	16	13
	Not sure	9	7.5
	Total	120	100
Stress frequency	Frequently	14	11.7
	Often	23	19.2
	Sometimes	78	65
	Never	5	4.2
	Total	120	100
Type of Stress	Domestic	32	26.7
	Work Pressure From Head	42	35
	Pressure From Colleagues	12	10
	Long Duty Stress	34	28.3
	Total	120	100
Environmental affect to Maintenance Personnel	Noise/ Vibration	28	23
	Inadequate light/Electricity	64	53
	Inadequate humidity	12	10
	Too hot	43	36
	Inadequate Ventilation	21	17.5

Source: Survey Data, 2019

As expressed in Table 4.9, most of Airlines managed to provide fair duty limitations for employee in accordance with MCARs requirements, as per 95(79.2%) responded as in fair duty Limitations. Though the respondents 25 (20.5%) said no fair duty limitations plan for employees. And most of maintenance employees are feeling stress just differing the frequency proving 115(95%) responded feeling stress whilst a few employees 5(4.2%) said no stress. Also the work pressure from head 42(35%), long duty stress 34(28.3%), Pressure from Colleagues 12(10%) are as in order.

Environmental effects to maintenance employees expressed inadequate light/Electricity 64(53%) occurring, un-shielding from weather too hot 43(36%), noise/vibration 28(23%), inadequate humidity 12(10%) are occurring in aviation maintenance field.

Table 4.11 Issues Occurring in Organization Concerning Safety of Aircraft

Statement	Responded Issues	No of Respondents	Percentage
Occurring Issues	Working with not completed safety Equipment	6	5
	Late Arrival to A/C Duties	4	3.3
	Leave without approval	4	3.3
	Unfair Duty Limitations for Flight engineers	12	10
	Pending Promotion for All staff accordingly	14	11.7
	Lack of Motivation Activities	8	6.67
	Not In time Safety Equipment Issue in Yearly	10	8.3
	No Issue	62	51.7
Total		100	100

Source: Survey Data, 2019

As occurring statement of issues in table 4.10, most of maintenance personnel responded no special issues 62(51.7%) concerning safety of aircraft. However, some issues for employees such Pending Promotion for all staff accordingly 14(11.7%), Unfair Duty Limitations for Flight engineers 12(10%), Not In time Safety Equipment Issue in Yearly 10(8.3%), Lack of Motivation Activities 8(6.7%) are still exist. Also the head view to safety concerns are working with not completed safety Equipment 6(5%), Late Arrival to Aircraft Duties 4(3.3%), Leave without approval4 (3.3%) are occurring in maintenance organization. Obviously found that facilities implementations for maintenance employees are still needed and some employees are not following to Airlines' existing disciplines.

Table 4.12 Management for human factor improvement

Statement	Type of Action	No of respondents	Percentage
Audit Plan for employees	Yes	118	98.3
	No	-	-
	Not sure	2	1.67
	Total	120	100
Human Error Investigation and Mitigation Plan	Maintenance Error Decision Aid (MEDA)	95	79.2
	Human Factor Analysis and Classification System	24	20
	Modification of MEDA	95	79.2
	Fatigue Risk Assessment and Mitigation Plan	23	19.2
	Others	-	-
Type of Training	General Familiarization	120	100
	On Job Training	115	96
	Company Procedure	120	100
	Human Factor	120	100
	Basic Maintenance Training	84	70
	Type Course Training	26	21.7
	Software handling Training	24	20
	Safety Management Training	77	64.2
	EWIS, CDCCL (Fuel Tank Safety)	84	70

Source: Survey Data, 2019

As expression in table 4.11Management to human factor improvement, audit plan for employees' human factor are carried out as proving 118(98.3%) respondents whilst 2(1.67%) in not sure response. Also Human Error Investigation and Mitigation Plan are carried in different forms in airlines such Maintenance Error Decision Aid (MEDA) and Own Modification of MEDA is mostly used plan 95 (79.2%) of respondents answered, Human Factor Analysis and Classification System are secondly showing 24 (20%) of respondents' statements and Fatigue Risk Assessment

and Mitigation Plan is still in least for maintenance personnel as stated 23 (19.2%) responded. As stated trainings such General Familiarization, On Job Training, Company Procedure, Human Factor are provided (99%) for improvement of maintenance employees. Basic maintenance training (70%) which are needed for line maintenance are provided. Safety management training (64.2%), EWIS (Electrical Wiring Interconnect System) and CDCCL (Fuel Tank Safety) trainings (70%) are in respectively. However, Type Course training (21.7%) and Software Handling Training (24%) are still in least due the financial concerns.

CHAPTER 5
CONCLUSION

This chapter provides the conclusion and recommendations drawn from the findings to explain the limitations and qualifications of human factor in Myanmar Aviation Industry.

5.1 Findings

According to the survey result, the limitations to maintenance personnel at their associated work scope as per the existing regulations of Myanmar DCA and exploring the qualifications of human factor in Myanmar Aviation Maintenance. To mitigate the costly occurrences including undesirable accidents, it is needed to be complied with satisfactory human factor implementations. That is why human factor is in vital. Thus, implementations of human factor in accordance with existing laws and requirements are needed to meet the international standards.

All employees at maintenance organizations know their duties and responsibilities and good knowledge level as per existing exposition of their Airlines, and well understand the training for Human Factor is in regular basis as per Myanmar DCA requirements. Most of AMO employees assume they are primarily responsible of airworthiness. It can be aware of the fact that AMO has regulatory, update and recurrent training plan. Despite update and recurrent training plan are given every one or two year as described, some employees do not acquire fully training as procedures.

In most of Airlines' financial support is still weak since our country is one of the developing countries to keep in breast with other countries. The facilities implementations are in medium range due (10.4%) of respondents answered in neutral and (1.3%) not agree AMO are prepared for good facilities implementations. Concerning the software facilities 10.3% of respondents in neutral and 2.8% in disagree of good software implementations in Airlines. In hard ware facilities,23.4% in neutral response and 1.7% in unsatisfactory perception on facilities, showing still need to implement the suitable hardware facilities and workplaces for employees.26% respondents in neutral perception and 7 employees are in unsatisfactory situation to

Hard ware and Environmental implementations of Airlines, showing still in need to implement. Also 26% respondents in neutral perception and 7 employees are in unsatisfactory situation to Hardware and Environmental implementations of Airlines, showing still in need to implement. Also a few employees about 24% not received the type course, software handling training due financial concerns.

It is difficult to get fully human factor supplementations. Approved facilities of human factor supplement mandated by local authority (Myanmar DCA) and facilities are still in demand. Calibrated external equipment, tools are mostly applied in line maintenance. Noticeable facts observed in some airlines have not sufficient equipment and materials, found loaning contract is applied when concerning tools is in need. And found most of airlines tools and equipment stores are in far apart of work place such airfield. Also sufficient mobile tools-carry is needed in some airlines support for in-time job completion of associated work scope.

Safety equipment such life vest, ear muff, and safety shoes provided by associated Airlines is still needed to renewal for specified intervals such yearly and most of employees using their budget for their protection.

Observed there are some issues for employees such pending promotion for all staff accordingly 14(11.7%), Unfair Duty Limitations for Flight engineers 12(10%), Not In time Safety Equipment Issue in Yearly 10(8.3%), Lack of Motivation Activities 8(6.7%) are still exist. Also the head view to safety concerns are working with not completed safety Equipment 6(5%), Late Arrival to Aircraft Duties 4(3.3%), Leave without approval4 (3.3%) are occurring in maintenance organization.

Observed noisy and weather affects to maintenance employees' work done inefficiency. Most of employees (95%) feeling stress including work pressure, domestic, and long duty stress including environmental effects and also not sufficient and fully protection work places such convenience rooms for environmental protection. Deficiency such electricity shortage for each maintenance offices is causing fatigue to employee in their working period.

Concerning human error investigation and mitigation management plan as per 24 (20%) of respondents statements , Fatigue Risk Assessment and Mitigation Plan is still in needed for maintenance personnel as stated only 23 (19.2%) responded.

5.2 Recommendations

From the study findings and the conclusion made, the following recommendations are put forward for the improvement of human factor in Myanmar Aviation Maintenance.

This should be a priority in airlines policy for human factor. From the study findings, the majority of the airlines respondents have been trained on Human factor requirements training. But there should be better practical trainings. All airlines should have a high level of human performance that cannot be attained by any single respondent since the level of human factor requirements preparedness at the airlines is, to a large extent, governed by the interaction of AMO departments. Perspicuous procedures and check lists for each maintenance scenario should be mandated for each department.

A better integrated overall facilities involving all maintenance departments operating at the airlines is thus needed. The explored limitations such software, hardware, environment and liveware should be implemented for each employees' abilities in top performance for mitigation the possible danger to aircraft safety.

Employees under AMO should follow exactly the human factor regulation because they are the ones who work near aircraft. Auditing plan for each employee during their working time should be practiced in order to make sure the safety practices. Responsible person from respective airlines must issue safety equipment constantly and regularly for their maintenance employees who work in a risky condition. Employees from line maintenance need to make installations and repairing to be perfect for a flight. Health care should be provided to workers under AMOs hence they feel environmental impacts such as noise, hot, etc. It can be supposed that human factor can be utilized completely if there is a fair transportation system for employees. Electricity insufficient for each maintenance offices, causing fatigue to employee in their working period, should be prepared back up electrical generation system for each AMO (Aircraft Maintenance Organization).

Most of employees (95%) feeling stress and the recommended procedures to use the risk and fatigue management plan in effectively and to manage the fair plan and procedures for each employees. Safety equipment such life vest, ear muff, and safety shoes provided by associated Airlines is needed to renewal for specified intervals. Fair duty limitations plan should be applied for each maintenance department. Fatigue Risk Assessment and Mitigation Plan should be practiced for

mitigating the employees' feeling stress depending upon their performance indicators. Also the individual reporting procedures should be perspicuous and should be easy access to use for their reports concerning safety and personnel feeling. As using Maintenance Error Decision Aid (MEDA) system in most of Airlines, systematic reward system should also be used to good employees such their promotion and appreciation for their motivation. To make sure that each maintenance departments are following in accordance with MCAR requirements, QA (Quality Assurance) department should establish the systematic auditing plans with qualified staffs.

Balancing the production and financial concerns, the effective and efficient human resources management plans depending upon the employees' performance, should be mandated in each expositions and HR manuals as per existing requirements of Myanmar DCA and practiced in regular basis.

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APPENDIX (A)

Airlines in Myanmar

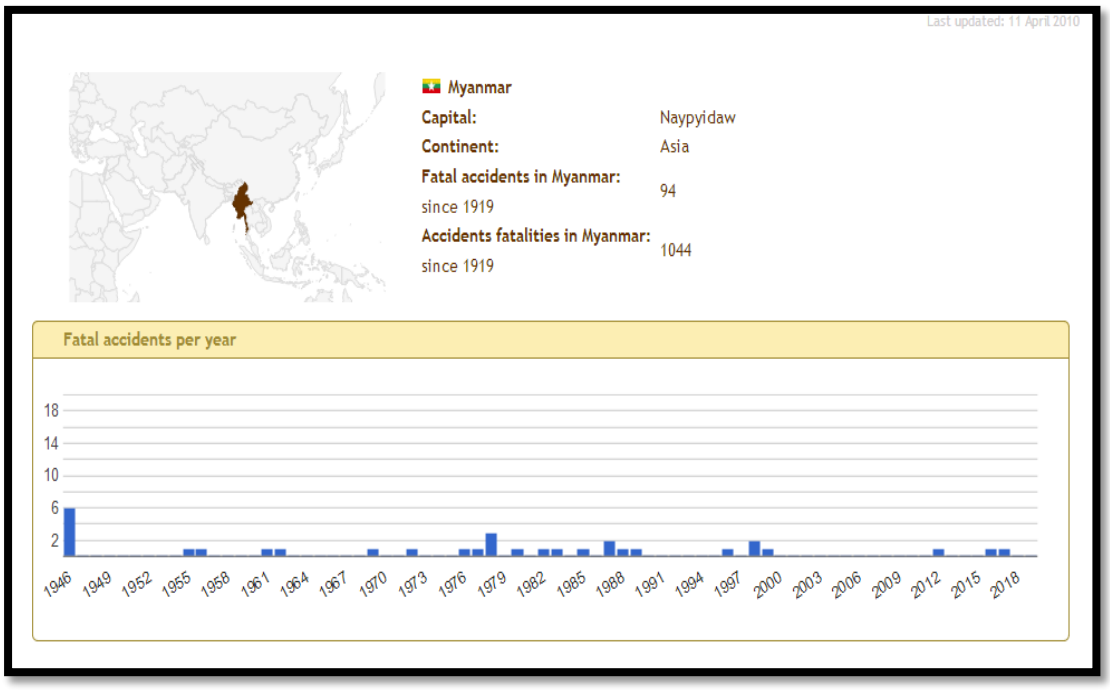
Airline	Commenced Operations	Ceased Operations	Note
Union of Burma Airways	1948	1972	Rebranded as Burma Airways
Burma Airways	1972	1989	Rebranded as Myanmar Airways
Myanmar Airways	1989	2014	Rebranded as Myanmar National Airlines
Air Bagan	2004	2018	
Air Inlay			Never launched
Air Mandalay	1994	2018	
APEX Airlines	2015	2018	
FMI Air	2012	2018	named *FMI Air Charter* from 2012-2014
Shwe Myanmar Airways	2012	2012	Rebranded as Golden Myanmar Airlines
Myanmar National Airlines	2014		
Air KBZ	2010		
Asian Wings Airways	2010		
Mann Yadanarpon Airlines	2014		
Myanmar Airways International	1998		
Yangon Airways	re-operate in1996		

Source: Department of Civil Aviation, Myanmar (MDCA)

Human performance role in civil aircraft accidents

Source: IATA, 1975

Safety Profile of Myanmar Aviation



Source: aviation Safety Network, 2018

Occurrences in Myanmar(2012-2019)

date	type	registration	operator	fat.	location
08-MAY-2019	DHC-8-402Q Dash 8	S2-AGQ	Biman Bangladesh	0	Yangon-Minga...
07-JUN-2017	Shaanxi Y-8F-200W	5820	Myanmar Air Force	122	near Dawei
10-FEB-2016	Beech 1900D	4601	Myanmar Air Force	5	near Naypyidaw In...
24-JUL-2015	ATR 72-212	XY-AIH	Air Bagan	0	Yangon-Minga...
14-APR-2014	Airbus A319-112	XY-AGR	Myanmar Airways International	0	Yangon-Minga...
14-APR-2014	Airbus A320-232	XY-AGT	Golden Myanmar Airlines	0	Yangon-Minga...
10-JUN-2013	Xian MA60	XY-AIP	Myanma Airways	0	Kawthaung Ai...
16-MAY-2013	Xian MA60	XY-AIQ	Myanma Airways	0	Mong Hsat Ai...
25-DEC-2012	Fokker 100	XY-AGC	Air Bagan	1+1	near Heho Airport...
17-FEB-2012	ATR 72-212A (ATR 72-500)	XY-AIT	Air KBZ	0	Thandwe Airp...

Source: aviation Safety Network, 2019

APPENDIX (B)

Questionnaire for maintenance employees of Airlines

Instructions

1. Please respond to all question and kindly note that all responses are valued
2. For questions where there are no options, you are to answer in own words.

Section A: Background Information

(1) Gender

[ ] Male [ ] Female

(2) Age

[ ] 21-30 [ ] 31-40 [ ] 41-50

[ ] Above 50

(3) What is your highest level of formal education?

[ ] Engineering [ ] Post Engineering [ ]Other Graduate

(4) What type of airline maintenance operation do you work for?

[ ] International Airline [ ] Domestic Airline

[ ] Both

(5) Working at

[ ] Quality Assurance Department

[ ] Line Maintenance Department

[ ] Engineering Services Department

[ ] Materials& Logistics Department

[ ] Other

(6) How many years of aviation experience do you have?

[ ] Less than 1 year

[ ] 1-5 years

[ ] 6-10 years

[ ] 11-15 years

[ ] 16-20 years

[ ] More than 20 years

Section B: Human Factor Knowledge and Information

(7) Does your Department apply good implementations compliance with Human Factor as per existing regulations?

[ ] Very well

[ ] Well

[ ] Neutral

[ ] Not well

[ ] Not at all

(8) Do you know your duty and responsibilities involved in Maintenance Organization Exposition (MOE) which approved by DCA?

[ ] Yes [ ] No [ ] Not Sure

(9) Should have regulatory training for each department concerning with human factor as per Myanmar Civil Aviation Requirements (MCAR)?

[ ] Yes [ ] No [ ] Not Sure

(10) What role does your department play in forming your organization's requirement for safety of aircraft?

[ ] Primarily responsible for forming all safety requirement and procedure with minimal input from other department

[ ] safety requirement and procedures with equal input from other department

[ ] Advises other departments that are primarily responsible for forming safety requirement and procedure

[ ] No role in safety requirement

(11) What type of special training do employees receive? (Please select all that apply)

[ ] General familiarization

[ ] On Job Training

[ ] Company Procedure

[ ] Human Factor

[ ] Basic Maintenance Training

[ ] Type Course Training

[ ] Software Handling Training

[ ] Others_____

(12) How often does your organization have the update and recurrent training plan for Human Factor knowledge?

[ ]1 Year [ ]2 Years [ ]3 Years

[ ] 4 Years and above

(13) Does you know the human Factor requirement as per existing regulation, MOE & company HR manuals?

[ ] Yes [ ] No[ ] Not sure

Section C: Overall Facilities Implementations of Maintenance Organizations

What is your organization implementation concerning Human Factor requirement as per MCARs?

Requirement for Human Factor (AMO)	Very well prepared	Well prepared	Neutral	Not well prepared	Not at all prepared
Housing & offices Facility Requirements					
Personnel Requirements compliance					
Equipment Tools and Material Requirements					
Certifying Staff and Category B1 and B2 Support Staff Requirement					
Acceptance of Components Requirement& Storage					
Maintenance Data Requirements					
Production Planning Requirement					
Certification of Maintenance Requirements as per existing regulations					
Maintenance Records Requirement					
Occurrence Reporting system					
Safety, Training, Quality Policy, Maintenance Procedures and Quality System					

Section D: Software, Hard ware, Live ware, Environmental Limitations

Software for Human Factor (AMO)	Very well prepared	Well prepared	Neutral	Not well prepared	Not at all prepared
Computer Based Manuals& updated Data for easy access					
Updated Check Lists& Perspicuous procedures for each maintenance tasks					
Communication Links between each Crews, Shifts, Department					
Shift Organization structure(Shift Pattern , Rest & Duty Limitations etc.)					
Individual reporting procedure for safety concerns (including SIR & SOR)					

Hard ware& Environmental for Human Factor (AMO)	Very well prepared	Well prepared	Neutral	Not well prepared	Not at all prepared
Aircraft Handling for each systems					
Safety Equipments (Ear/Eye protection etc.)					
Transportation, communication support equipments					
Sufficient Calibrated tools & Equipments					
Health support facilities (clinic, medical- box, Hospital)					
Proper working places creation (Suitable Housing &allocation etc.					

Live ware for Human Factor (AMO)	Very well prepared	Well prepared	Neutral	Not well prepared	Not at all prepared
Updated & recurrent Trainings					
Personnel Skills Training for each work scope					
Preventions to Dirty dozens					
Human Resources Allocations (Efficient Employees for each Department& work scope)					
Human Resources Management Plan for each employees					

Section E : Monitoring and Management

(1) What is your organization's approach to human error investigations? Which of the following approaches does your operation use to investigate human error? (Please select all that apply.)

[ ] Maintenance Error Decision Aid (MEDA)

[ ] Human Factors Analysis and Classification System (HFACS)

[ ] Our own modification of MEDA

[ ] Fatigue Risk Assessment & Mitigation System

[ ] Others _____

[ ] None

(2) Does your Department have audit plan for individuals to make sure not using the alcohol& drugs usage during 8 hours prior to working time?

[ ] Yes [ ] No [ ] Not Sure

(3) Does your Department have a fair duty limitations, i.e. minimum rest period of 8 hours prior to the beginning of duty and not more than 12 consecutive hours of duty?

[ ] Yes [ ] No [ ] Not Sure

(4) How often have you ever felt stress whilst performing your job?

[ ] Frequently

[ ] Often

[ ] Sometimes

[ ] Never

(5) What type of stress do you ever feel at your working time?

[ ] Domestic stress (Family case, financial etc)

[ ] work pressure from Head (supervisors/managers etc)

[ ] Pressure from colleagues

[ ] Others_____

(6) Check any of the environmental factors that you feel affected your job performance?

[ ] Noise

[ ] Inadequate light/electricity

[ ] Too hot

[ ] Vibration

[ ] Inadequate ventilation

[ ] High humidity

[ ] Other (list) _____

(7) Please list the issues you occurring in your organization concerning safety and human factor implementations?

_____

_____

_____

_____