Human Factors in Aviation Maintenance

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 Abstract

The study of Human factors involves the application of scientific knowledge to understand human capabilities and limitations to establish safety between people and the system in which they operate. Effective use of knowledge on human factors can help in reducing the probability of errors as well as establishing a more error tolerant and resilient system. Humans have an ultimate responsibility of determining the success and safety of aviation industry despite the rapid technological gains. Studies have continuously documented human error as the primary contributor to 80 percent of airplane reported accidents and incidents. Transport Canada identified twelve essential human factors that account for the worldwide occurrence of reported incidents and accidents. In the introduction, this paper defines human factors in details before identifying and describing the twelve essential human factors as documented by Transport Canada. For instance, the paper employed secondary methods of data collection to provide an account of different statistical incidences and accidents. More information was drawn from Federal Aviation Administration website to provide a vivid statistical account of historical accidents and incidents originating from human errors. The paper provides a description different strategies put across to minimize human factors in the aviation industry. The paper utilized Boeing airline as the best case example. The Boeing airline operates on a unique design philosophy of building airplanes that are safe while offering operational efficiency. The paper attains an evidence-based conclusion after examining a number of strategies used in making human factors improve safety in the aviation industry.

*Key words: incident, accident, human factors, complacency, fatigue and maintenance.*

Introduction

The World Health Organization terms human factors as organizational, environmental and job elements that revolve around individual and human characteristics affecting behavior at work in a way that can influence health and safety. Salas and Maurino (2010) provided a standard definition of human factors as a discipline that deals with the human-machine interface. For instance, Salas and Maurino (2010) ascertain that human factors deal with psychological, physical, social, biological and safety characteristics of individuals and groups.

In most cases, human factors incorporate organizational and environmental context at its sharp end. Human factors in aviation have its roots to the earliest day of the flight. Aviation pioneers expressed great concern about the welfare of those who flew their aircrafts. As the capability of vehicles expanded, the aircraft rapidly exceeded the human capability of directly sensing and responding to the vehicle and the environment, to exert sufficient control to ensure optimum outcome and safety of the flight.

Historically, there is four distinct stages that human factors in aviation underwent before attaining the current status. The steps include early days before the First World War, the World War I period, the inter-war period, Second World War era. After the second world, more inventions occurred in aviation industry marking the end of capitalism characterized by cold weather operations, jet period and the cold war error that erupted from arctic research. Scientists had to undertake a number of studies to address the extreme climatic levels in the vast wastelands of Alaska experienced during the cold weather operations (Wise, Hopkin & Garland, 2009).

At any point in the history of human factors in aviation, one could characterize its current state at that time by the progress achieved with the opportunities that presented themselves for the future. This paper will examining the extent of the contribution of human factors to aviation accidents coupled with provision of evidence-based statistics related to aviation accidents and related issues. In addition, this paper will address efforts put in place in the aviation industry to minimize human factors as well as strategies put across to utilize human factors in the improvement of safety.

The contribution of human factors

As mentioned above, human factors revolve around four major components: People who do the job, their working environment, the activities they undertake and the resources necessary to complete the job. Consequently, the four facets play a significant role in determining whether an accident will occur or fail. The list of human factors that affect aviation maintenance and work performance is broad. For instance, the study of human factors is multidisciplinary and very diverse. Human factor science shares much knowledge with engineering, anthropology, statistics, operations research, psychology and industrial design.

Human factors cover a wide range of challenges that influence people and resources differently as humans do not have the same capabilities, strengths, weaknesses or limitations. Unfortunately, aviation maintenance tasks with little human limitations can result in technical errors and injuries. Some injuries may be more severe compared to others; however, a combination of three or four of the factors can result in a problem that contributes to an accident or incident.

According to Federal Aviation Administration (2014), aviation safety relies heavily on maintenance. Incorrect aviation maintenance contributes to a significant proportion of aviation accidents and incidents. Examples of maintenance errors in aviation include: incorrectly installed parts, missing parts and failing to perform necessary checks. The most difficult threats to detect in aviation maintenance are the mistakes of an aircraft maintenance technicians. In many cases, such errors are always present but invisible.

They may remain latent to impact on the safety operation of aircraft over a long period in future. Human conditions such as fatigue, stress and complacency are very crucial in aviation maintenance. They directly cause or contribute to many aviation accidents. For instance, it is universally agreed that 80 percent of maintenance errors that result in accidents in the aviation industry involve human factors (Federal Aviation Administration, 2014). If not detected such factors can cause events, worker injuries, wasted fines and accidents.

According to the Federal Aviation Administration (2014), the Transport Canada identified twelve human factors that degrade people’s ability to perform efficiently and safety which could lead to maintenance errors and result in fatal accidents. Transport Canada’s decision resulted from the increased cases of maintenance related accidents and incidents that pervaded variation in the industry in preceding decades, that is, 1980s and 1990s. The aviation industry adopted the twelve factors known as the “dirty dozen” to serve as a straightforward means to address a human error in maintenance.

It is important to familiarize ourselves with the dirty dozen, recognize their symbols, and comprehend on how to contain or avoid errors created by the dirty dozen. However, it is vital to understand the collaboration between, work group, organizational and individual factors that could result in errors and accidents. AMTs has a role to play in preventing or managing such errors proactively in the future.

**Lack of communication**

**Faulty maintenance, suboptimal, incorrect, or faulty maintenance may result from lack of communication. For instance, communication occurs between AMT and different key players in the aviation industry such as managers, parts suppliers, pilots and the aircraft servicers. Despite the fact that each exchange holds potential for misunderstanding, communication between AMTs is the most important of all. Lack of communication between technicians results in maintenance errors and result in aircraft accidents.**

**Accidents are prone to occur where more than one technician perform maintenance procedures on a single plane. Aviation industry advocates for the exchange of accurate and complete information to ensure completion of all work to omit maintenance errors. However, confusion occurs during changes in shift or fixed base operator (FBO) operation where technicians may transfer a partially completed job to the next one who fails to perform it in the best way.**

**In a scenario where the departing professional fails to explain all the procedure to the arriving technician, he/she gets confused on how to conduct the task. According to the Federal Aviation Administration (2014), the arriving technician should review the paperwork and feature ahead to complete the next steps as documented.,4**

**Complacency**

**Federal Aviation Administration (2014) terms complacency as a human factor that usually develop over time. Technicians tend to develop a sense of self-satisfaction and false confidence as he continues to gain knowledge and experience. Such practitioners may easily neglect some areas especially in maintenance jobs where they perform inspections regularly without getting any fault. Assumed faults could result in accidents or incidents. Complacency may exist in circumstances the technician performs different tasks without documentation leaving his mind to wander around in comfort. Technicians must stay in a mentally engaged state in order to detect faults that led to the inspection in the fight to combat complacency.**

**Lack of knowledge**

**Lack of knowledge is a human factor that poses a significant challenge to the aviation industry. In most cases, inadequate knowledge when executing an aircraft maintenance can erupt into an accident due to faulty repair characterized with catastrophic results. Different technologies, maintenance procedures and skills required in performing maintenance is a challenge to the technicians who may have competence on a single type of airplane.**

**Federal Aviation Administration (2014) requires all maintenance performed to meet standards as stated in the approved instructions. Technicians should ensure use of the latest applicable technology and information while following each step as stipulated in the guideline. It is important to contact the manufacturing technician in case the company employed professionals fail to perform the maintenance as stipulated than doing the procedure incorrectly and causing accidents.**

**Distraction**

**Diversion has a great association with distraction of technicians in maintenance and refers to anything that can take one mind off the task being performed. Distractions may cause the technician to think that he is far with the procedure than he/she is. The technician may skip a situation that requires more attention. Federal Aviation Administration (2014) reports that distractions account for 15 percent of errors related to aviation maintenance. Distractions can occur when the work is in progress either on the aircraft or in the hunger. Distractive activities occur either in mental or in the physical form of nature. Phone calls, family or social issues may distract the attention of the technician leading to ineffective maintenance work.**

**Lack of teamwork**

**Lack of cooperation has a close relationship with the lack of communication and may also contribute to a number of errors reported in aircraft maintenance. According to the International Association of Fire Chiefs (2010), teamwork encourages information sharing among technicians as well as coordinating the maintenance work in the aviation industry. Teamwork not only encourages participation and understanding before taking action but also leads to improved safety in the workplace. It is important to educate everyone on emergency response in case of accidents including fire breakouts.**

**For instance, operations such as gear swing involve everyone and all technicians to achieve a single outcome. Teamwork encourages everyone to remain focused on performing his/her role leading to the success of the organization. Contrary, lack of collaboration makes all maintenance operations difficult leading to miscommunication that affects the airworthiness of the aircraft. Lack of commitment and proper coordination of the team is a risk factor too occurrence of accidents.**

**Fatigue**

**Spielberger (2004) concurred with the FAA findings and regards fatigue in the aviation industry as a major human factor that contributes to many maintenance errors leading to accidents. Fatigue relates to distraction and may appear in the form of mental or physical nature depicted as emotional fatigue. Reduction or impairment in decision-making, reaction, coordination, strength, speed, balance and cognitive ability contributes to fatigue. Notably, fatigue can reduce a technician’s alertness and lowers his ability to focus and maintain attention on the task being performed.**

 **For instance, aviation psychologists have documented substantial work in the area of fatigues at the National Aeronautical and Space Administration Research Centre. More work is in progress to gain a better understanding of the effects of fatigue on aviation operations (Spielberger, 2004). However, aviation psychologists working for military examined scheduling practices and pharmacological countermeasures to mitigate the effects of fatigue in military aircraft.**

**Lack of resources**

**Lack of resources leads to lack of supply and support that may interfere with the technician’s ability to complete the maintenance operation. Aviation maintenance requires proper tools and parts to maintain a fleet of aircraft. Lack of resources can result in both fatal and non-fatal accidents. However, availability of adequate resources results in quality and more efficient maintenance. Organizations should learn to use sufficient resources available to make the necessary maintenance. Use of appropriate and quality resources saves time, financial costs and enables organizations to complete their maintenance operations efficiently.**

**Pressure**

**The aviation industry demands that technicians do their maintenance tasks in an environment with the constant pressure that has the constant pressure of performing operations without making mistakes. Contrary, such types of job pressures may affect the capability of maintenance workers and technicians to perform efficiently. The airline strict financial guidelines and tight flight schedules exert a lot of pressure on mechanics to detect, identify and repair mechanical problems quickly for the airline industry to maintain its operation.**

**Such technicians face a lot of pressure that can affect their wellbeing and increase confusion that, in the long run, may result in aviation accidents. In the struggle to mitigate the risk, mechanics should avoid self-induced pressure. In addition, they should communicate if they need more time to accomplish their task rather than rushing through it to cause accidents later. If at all time presents the main challenge, technicians should always ask for extra help from other technicians and mechanics to foster teamwork and in the run to achieve the industry aims and objectives.**

**Lack of Assertiveness**

**Assertiveness refers to being in a position to express your opinions, feelings, beliefs and needs in a positive, productive manner without confusing it with aggressiveness (FAA, 2014). Technicians need to practice assertiveness and air out their concerns during aviation repair rather than keeping it to themselves to the extent of causing accidents and incidents. Notably, failing to be assertive has direct consequences of costing people’s lives. Technicians should address managers directly by stating their concerns while explaining the consequences that may accrue. In addition, it is vital for such professionals to propose possible solutions to the problem while soliciting feedback with the inclusion of other opinions.**

**Stress**

**Federal Aviation Administration (2014) terms the aviation maintenance as a stressful task due to many factors. Aircraft must be functional throughout and maintenance needs to occur quickly to avoid cancelations, delays and consequently lose. Notably, vast dynamic technological advancements have the effect of increasing stress to technicians. ATMs have to spend most of their resources and time on training and competence maintenance. Different people respond to stress differently, however, there are other sources of stressors such as working in the dark, lack of resources and long working hours. Stressors appear in physical, psychological, and physiological form.**

**Lack of Awareness**

**The lack of foresight and failure to recognize all the consequences have far-reaching consequences for aviation maintenance. Being aware of different aspects of aviation maintenance leads to competence and experience. However, technicians may face the challenge of losing vigilance and develop a lack of awareness of performing the same task repeatedly. Each time a task is completed it must be treated as if it were the first time. Technicians should always check to determine whether the modification or repair addressed the situation. It is important to involve co-workers to assess the quality of your work to ascertain if at all it will meet the expectations of the company.**

**Norms**

**Norms refer to unwritten rules followed or tolerated by most organizations. Negative rules may detract an organization from the set safety standard and result in the occurrence of an accident. For instance, organizations develop rules to solve problems with ambiguous solutions. Unsafe norms have a variety of effects ranging from relatively benign, such as determination of accepted time for meeting. Nevertheless, any behavior commonly accepted by the group, whether as a standard operating procedure (SOP) or not, can be a norm.**

**It is the role of all supervisors to ensure that everyone adheres to the same standards without tolerance of unsafe norms. In addition, technicians who perform the role of maintenance have the responsibility of following organizational set procedures rather than sticking to unsafe standards adopted as regular practices.**

**Statistics of human factors in maintenance contribution to aviation accidents**

**As mentioned earlier, most of the aviation incidents and accidents erupt from errors related to human factors in maintenance. Different organizations including the Federal Aviation Administration (2014) documented a number of accidents related to human error. According to FAA (2014), human errors account for 80 percent of the aviation accidents whereas as machine failure accounts for 200 percent of all accidents. FAA (2014) provided a detailed account of incidents and accidents that occurred in different years at different years of the time.**

**Statistical Incidences**

**The first incident recorded occurred on 26 August 1993. A 320 Excalibur Airways Airbus left London-Gatwick Airport just to face a roll to the right on takeoff. The condition persisted until the plane landed back at London-Gatwick 37 minutes later. According to FAA (14), the aircraft control required vital left side stick at all times. However, the loss of spoiler control accounted for the degradation of the flight control system. The investigators revealed that the technicians familiar with the flap change procedures of Boeing 757 lacked the knowledge that could guide them to lock correctly out the Airbus spoilers. Failure began from the event of the flap change work done the day before the plane took off.**

**However, the turnover technicians on the following shift compounded the problem. The departing technician did not mention nor give out any incorrect spoiler lockout procedure. The investigators assumed that the 320 was similar to the 757. For instance, the arriving technician checked the flap change operationally as the spoiler remained locked. The flight crew did not detect spoiler during standard functional checks hence lacking Airbus procedure knowledge was the primary cause of the incident.**

**Another historical aircraft incident occurred on 26 April, 2001. The left main landing gear for a worldwide Emery Airlines DC-8-71F failed to extend for landing. Technicians noted inspection failure to comply with post-maintenance test procedures as part of the causes of the incident. The cause of the incident was the maintenance failure to install the correct hydraulic landing gear extension component. However, the Aviation industry recorded no injury.**

 **In 1983, Eastern Airlines experienced another tragic incident. The Lockheed L-1011 carried 172 people on board: 10 crewmembers and 162 passengers from Miami in United States to Nassau in Bahamas. Surprisingly, the low oil pressure light on the center engine illuminated as the plane descended into Nassau. As the shutdown, the captain decided to go back to Miami the two remaining engines. 15 minutes later after shutting down the center engine, the right engine flamed out. As the flight crew attempted to restart the center engine, the left engine also flamed out.**

 **The flight began descending without power at 13,000 ft. The passenger got ready with their jacket in preparation for ditching. No injuries occurred on the occupants as the aircraft made one engine landing at Miami International Airport a half an hour later. During the investigation, the technicians revealed that other technicians had installed magnetic chip detectors without O-rings. The absence of the ring allowed oil to leak from the engine in flight. Despite the engine problems posting the great challenge to the maintenance errors, the investigators revealed deeper organizational issues.**

**United States experienced another airplane crash incident on 28 September, 2007 where the American Airlines Flight 1400 DC-9 faced an in-flight engine fire as it left from Lambert-St. Louis International Airport (STL). The nose landing gear failed to extend as the flight crew experienced a go-round making the team reach the nose gear via the use of the emergency procedure as the airplane returned to STL. Consequently, the flight crew managed to perform an emergency landing where 2 flight crewmembers, three attendants, and 138 passengers deplaned on the runway. The management reported no injury despite the ability of the airplane to sustain substantial damage from the fire. However, investigators reported that the maintenance personnel’s used an inappropriate manual engine start procedure.**

**Statistical Accidents**

**A series of tragic accidents occurred since time in memorial drawing great attention to the human aspects of maintenance. According to Hobbs (2008), the world experienced the most terrible single-aircraft accident in August 1985. The Japan Airlines Boeing 747 accident claimed 520 lives. The airplane left Tokyo, Japan on a short flight to Osaka. As the plane attained its cruising altitude of 24,000ft, the cabin experienced faced a sudden decompression as the bulkhead experienced pressure.**

**All the four systems lost their hydraulic pressure leaving the plane uncontrollable. After 30 minutes, the plane crashed into a mountain. The interpreters highlighted potentials for maintenance errors to remain dormant for an extended period before flying. The rear pressure bulkhead failed due to a fatigue fracture in an area where a repair occurred years ago. The repair involved replacement of a lower half of the partition.**

**In April, 1988, the world recorded another tragic accident. The Aloha Airlines Boeing 737 left from Hilo in Hawaii to Honolulu to experience an explosive decompression leading to the separation of the passenger floor line from the aircraft. The flight encountered a diversion to Maui for an emergency landing. Investigators concluded that occurred due to the failure of airlines to detect significance fatigue damage that ultimately resulted in the failure of the lap joint hence separation of the part of the fuselage. Human factors of inspection posed the greatest issue of concern especially in the United States.**

**According to Hobbs (2008), Britain recorded another tragic accident involving the British Airways BAC-111. Hobbs (2008) reports that a windscreen of the jet blew out as the aircraft climbed to its cruising altitude. Shockingly, the jet partially ejected the pilot through the window. Situational analysis revealed that a maintenance shift manager installed the windscreen during the previous night shift. However, the management short-staffed the maintenance manager leaving the general manager to attempt helping out by completing the task on his own.**

**Notably, neither did the maintenance manager check thoroughly the maintenance manual before performing the task nor did he refer to catalog parts as illustrated. The manager did not confirm the type of bolts required to maintain the windscreen in place. Nevertheless, Hobbs (2008) confirms that the manager selected the bolts via attempts of physically matching them against a particular lock fitted on the old windscreen.**

**He assumed that the old bolt was the appropriate type with the ignorance of the store supervisor’s advice. The screws used were of smaller diameter from the initial ones. However, the manager did not notice the excessive amount countersink that remained within the bolt heads. Investigators highlighted night shift issues, staffing levels, storage, and supervisor involvement as the central human maintenance issues. The accident highlighted on how a single maintenance error could an aircraft compromised safety.**

**On 25 May, 2002, China recorded another fatal accident. The Airlines Flight 611 Boeing 747 killed 225 people on board after breaking and crashing into pieces in midair. Analysts reported that the accident was as a result of metal fatigue originating from insufficient maintenance that occurred in a previous incident. On 26 August, 2003, the world experienced another fatal accident where a Colgan Air Beech 1900D crashed after leaving Hyannis in Massachusetts.**

**The accident claimed the lives of the two pilots. Analysis and investigations revealed that managers improperly replaced the forward elevator trim cable with inadequate functional check resulting in the loss of control of the flight. The investigators identified the aircraft manufacturer’s erroneous depiction of the elevator trim drum and the flights failure to adhere to the checklist procedures as the primary causes of the accident.**

**According to Hobbs (2008), Flight International identified technical and maintenance failure as the leading cause of airline accidents and fatalities in 2003. For instance, deficient maintenance accounted for 7 out of 14 recent aircraft accidents. In addition, Hobbs (2008) reported that maintenance errors was not only a threat to the flight safety and security but could also result in financial costs.**

**Such costs are a result of cancelations, diversions, delays and other related schedule disruptions. A good example is whereby a flight cancelation of a large aircraft such as a Boeing 747-400, implied financial costs of approximately 140,000 US Dollar. Consequently, a delay at the gate meant an economic loss of 7,000 US Dollar per every hour. The United Kingdom Civil Aviation Authority (CAA) conducted detailed research on maintenance sites in the effort to examine the most frequently occurring maintenance discrepancies.**

 **CCA identified a number of errors frequenting the causes of accidents. Among them, there was an incorrect installation of airplane parts and essential components, fitting of wrong parts, discrepancies in electrical wiring including crossing connections and failure to lubricate. In addition, there were issues with forgotten tools, failure to remove lock pins, failure to secure fuel or oil caps and fuel panels as well as failure to secure access panels, fairings or cowlings.**

**National Transport Safety Board (NTSB) has the responsibility of conducting research and reporting the safety of civil aviation in United States. NTSB (2011) annual statistics reports indicated that the country continued to record incremental improvements across most of the civil aviation industry segments in 2010. The report recorded, a variety of non-fatal accidents were scheduled ‘part 135’ commuters had six accidents while twenty-six accidents reported sprout from US scheduled part 121 airlines.**

**Despite a trivial increase in the number of annual flight hours from 2,901,000 to 2,960,000, the total number of accidents on-demand operators reduced from 47 in 2009 t0 31 in 2010. On-demands operators were deliberately used to refer to air taxi, charter, air medical operations and air tour. The report, however, noted an increase in the number of fatal accidents from two in 2009 to six in 2010 accounting for a total number 17 fatality cases for the two consecutive years.**

**NTSB (2011) reported that the country would continue to enjoy from a downward trend and a decline in general aviation accidents from 2010 onwards. However, NTSB pointed out that the aviation sector would continuously account for the highest number of civil aviation and fatal accidents. For instance, in 2010, United States recorded a total of 1,435 civil aviation accidents where 267 of the recorded accidents were fatal leading to 450 fatalities.**

**Strategies put across to minimize human factors in the Aviation Industry**

According to O'Connor and Cohn (2010), it would be reasonable for the aviation industry to address human factors components of accidents and incidents if it has to minimize the accident rates beyond the current levels. The FAA began to use HFACS in 1999 as a vital tool for examining human factors associated with GA accidents regarded as the leading cause of fatalities in the civil aviation domain. HFACS tool assists in the identification of human causes of an accident and offers a tool to help in the investigation process. The tool primarily aims at providing training and equipping individuals with prevention efforts, skills, knowledge and approaches to prevent human factor errors (Jacko, 2009).

 Previous studies have shown reliability in the use of HFACS to identify and classify general human factor trends concerning military and general aviation accidents (Shappell.et al., 2006). The efficient use of tool assists the aviation industry to take precautionary steps required in preparation for emergency and conducting appropriate response in case an incident or accident occur. In addition, the aircraft maintenance system has worked effectively to establish different programs to reduce current Human Factor in the aviation industry.

The aviation industry developed Maintenance Resource Management (MRM) to offer appropriate training in understanding and preventing the occurrence of human factor errors. A few years later, MRM evolved into Human Factor in Maintenance to address capacity building and training in the effective eradication of human factors. In recent years, the senior management achieved the main breakthrough by laying emphasis on organizational human factor programs. Notably, many companies, organizations, and consultants have continuously enjoyed this upward focus on Human Factors.

Nevertheless, many aviation companies widely adopted the Gordon Dupont, Transport Canada’s consultant’s tremendous “Dirty Dozen” classification of the root causes of Human Factors. In addition, some organizations such as Boeing continuously laid focus on developing personal in-house Maintenance Error programs. Boeing also developed a Decision Analysis (MEDA) program while investing heavily in a more in-depth analysis. Boeing goes further to analyze the background of personnel involved in the commitment of human factor error maintenance in order to understand the best solutions.

Boeing airline industry adopted a number of strategies with the recognition that over the past decades, safer and reliable designs accounted for a significant progress made in the reduction of accident rates and enhancing efficiency. Boeing identified four areas of responsibilities in addressing human factor issues in maintenance. The four areas encompass flight deck design, error management, passenger cabin design and the design for maintainability.

The company uses analytical methods such as simulator evaluations and mockup to assess how well various design solutions meet the requirements of safety in the aviation industry. The technology used in terms of design has to meet safety requirements in terms of customer input, appropriate automation degree, the capability of crew integration and proper communication. The company involves customer input in deciding the best design of an airplane before developing and launching it.

 Appropriate automation degree assists the company offer help to the flight crew but not replacing them. Boeing provides audio, visual and tactile methods to foster effective communication among the staff members to build the best teamwork while eradicating confusion and complacency. The inter-linkage between pilots, technicians and flight crew members uses both tactile and visual feedback that provides more immediate feedback compared to verbal coordination.

The inter-linkage assists pilots and technicians to help each other in case of critical emergencies. In terms of communication, flight crew have many expectations to meet in route planning. Communication and cooperation between human factor specialists such as data link communication engineers and end users led to changes that increase user comprehension, reducing error rates and decreases training requirements.

Boeing employs a variety of strategies to address human factor issues of aviation maintenance such as chief mechanic participation, computer based maintainability design team, fault information team and the customer support processes. The company developed two tools including the Procedural Event Analysis Tool (PEAT) and Maintenance Error Decision Aid to prevent human errors in the future. PEAT is an analytical tool developed to assist the airline industry to manage risks associated with the flight crew procedural deviations effectively.

Training on the use of PEAT began in 1999 and assumed that there are reasons why people fail to adhere to a procedure. For instance, PEAT served as the first industry tool focusing on the procedurally related incident and accident investigations by the use of a consistent and structured manner to develop effective remedies. MEDA as a tool began in 1996 when Boeing launched a program in Human Factor Process for reducing Maintenance errors to collect more information about maintenance errors.

Other tools that help in the management of errors include training aids, use of improved automation and crew information requirement analysis. The passenger cabin design is a direct representation of a human factor challenge in relation to both passenger and cabin crews. Automatic overweight exit and other cabin applications illustrate how passenger cabin may benefit from human factor expertise applied during design.

Most of the programs adopted in the aviation industry aim at identifying human errors and educating the personnel involved in their causal potential. Managers design the programs in a way that they can suggest and provide the best strategies to either contain or correct the problem while setting a human factor-free environment. Despite the ability of the programs establishing safety in the aviation work environment, most of them still view human factors at a six ‘people’ perspective rather than the perspective of an “an organization” perspective. There is still need to create programs that target to improve the performance of all areas of the entire company.

 Programs addressing the entire organization provides long-term solutions to Human Factor in Maintenance. In addition to the existing programs, some countries have widely used the Performance Excellence Framework (PEF) in several sectors. PEF addresses the reduction of human factors in vital areas such as education, tourism, healthcare, housing, transport, and communication. The defense industry has continuously used PEF to gauge its quality health and to meet its expectations.

The Malcolm Baldridge National Quality Award (MBNQA) established in 1988 provides the best example of such frameworks. MBNQA covers all business such as Human Resource Development, Process Management, Strategic Planning, Information Management and the practical use of the results (Hertz, 2004). Performance excellence primarily aims at establishing a culture of continuous innovation and improvement that always relies on a strong foundation of professionalism, quality, and team excellence.

**How to make human factors improve Safety in Aviation Industry**

NOPSEMA (2015) terms that the identification and management of human factors as a critical step towards efficient and reliable reduction of maintenance risks. Understanding human factors influencing employees and different responsible parties enable them to implement the targeted solutions for improving human reliability and reducing errors. There are different strategies designed to identify and optimize human factors. Such policies contribute to the reduction of maintenance risks to the recommended levels.

 In addition, such strategies can help the responsible parties to meet many of their obligations. For instance, many studies have over long time identified human error as the primary contributing factor to incident and accident causation. Frequently cited statistics indicates that human error is responsible for the 80 percent of incidents and accidents occurring due to aviation maintenance process. Most of the accidents have a direct link to remedial actions such as training and disciplinary actions at an individual level.

According to NOPSEMA (2015), a human error occurs as an outcome of poor human reliability. This section discusses different strategies that the aviation industry should adopt such strategies to make human factors improve safety. For instance, there are various human factor approaches that can play an integral role in improving safety in the aviation industry. Such factors revolve around the adoption of vital policies such as the Maintenance Resource Management (MRM), the Maintenance Error Reduction, and the Job Task Analysis in Aviation Maintenance Environments.

Maintenance Resource Management (MRM)

According to FAA (2014), MRM is an umbrella term with the limited clear definition with some of its current program paralleling those of the Crew Resource Management (CRM). However, proper utilization of CRM programs results in improved teamwork and fostering good coordination coupled with enhanced team performance and efficient team communication. Research into the issue of airline safety shows interesting results in relation to the useful application of the MRM tool in addressing and improving human factor. For instance, MRM can improve communication and establish the best teamwork as part of the significant human factors.

Maintenance Error Reduction

Reduction of errors in aviation industry serves as an essential activity in establishing proper safety. The best approach to manipulating human factors to address safety aspects is by strengthening on error classification, identification, mitigation, and reduction. Error reduction has a close relationship to training and availability of adequate resources as part of the Human factors that contribute to aviation accidents. The aviation industry has a role to play in developing techniques and methodologies to enhance proactively safety by minimizing errors accruing from aircraft maintenance.

Job Task Analysis (JTA)

JTA technique helps in determining the necessary skills, knowledge and abilities needed to perform different tasks in a given job. JTA analysis is essential when used as in curriculum development. It keeps all staff members in the aviation industry focused on their role while avoiding complacency as analysis occur before and after the task. Technicians remain focused and committed to performing their various assigned tasks.

A good example is whereby FAA is supervising a JTA to develop understanding of the current tasks that aviation maintenance technicians (AMT) perform. The project is in progress since 1997 under the sponsorship of Federal Aviation Administration in United States. For instance, the research collaborates with all sectors related to the aviation maintenance community to update and upgrade training standards technician for all professionals involved in aviation maintenance in the contemporary and future environment.

Maintenance and Inspection Training

Organizations should conduct detailed studies and research in the area of maintenance and inspection training. However, such approach calls for the improvement of the maintenance training curriculum and delivery systems. In addition, organizations need to conduct proper analysis and investigation of the new technology for improved training methods and safety in the aviation industry.

It is important for all prototype training products to be pragmatic and target to provide a measurable change in human performance in aviation training, maintenance, and inspection. Proper analysis and investigation of personnel selection methods and workforce are critical in assessing the competence and professional adaptation to the task performed by a particular technician. Study of personnel selection techniques will assist in addressing the lack of knowledge as a human factor.

Job Aids for Maintenance and Inspection

Research indicates that job aiding appreciates the capabilities, requirements and limitations of human support personnel in an effort to establish the recommended security in an organization. There are different areas identified where human performance has far-reaching safety benefits in terms of improved or new support tools. Job Aids for Maintenance and Inspection program develops tools that support AMT performance in the effort to improve safety in the maintenance aviation department. In addition, such program plays a role in job feasibility and effectiveness analysis, thereby contributing to security improvement via enhanced task performance.

Information Dissemination

Dissemination of information is essential in maintaining safety in the aviation maintenance community. Dissemination of information in all departments of the airline industry enhances safety by encouraging effective use of appropriate technologies.

Communication and Harmonization

NOPSEMA (2015) recognizes aviation safety as an international activity. For instance, organizations should conduct research programs that cooperates with a range of other international organizations, airlines, and governments to establish adequate safety in the aviation maintenance community. NOPSEMA (2015) outlined some cooperative efforts as examples of collaborations that can improve safety through strengthened communication and harmonization.

The first case example is the joint performance agreement among Transport Canada, the FAA and the Civil Aviation Authority (CAA) in United Kingdom, and Transport Canada. Another collaboration and networking example sprouts from the mutual collaboration between Air Transport Association (ATA) and the International Civil Aviation Organization (ICAO). National Air Transport Association (NATA), International Air Transport Association (IATA) and a range of U.S. and international carriers exhibit mutual relationship.

In addition, organizations have the responsibility of ensuring appropriate research and identification of all eminent risks in the aviation maintenance tasks. Every organization has to establish a committee to foresee all health safety practices. The committee should function to meet the Occupational Health and Safety Act (OSHA) ¬ regulations. In addition, the committee shall always assist in the inspection of the maintenance condition as it will comprise of members selected from the technicians.

Legislation

Apart from creating awareness through education and community sensitization, law accounts for the establishment of recommended safety within the aviation maintenance section. The law revolves around setting sound policies, rules, regulations and standards that will guide everyone in the organization for mutual and joint working. Different countries have different policies and regulations followed by everyone working in the aviation industry in ensuring the establishment of safety within the aviation industry.

United Kingdom approved Part-145 to help all aviation organizations to meet requirements concerning human factors in the aviation maintenance for the establishment of security. In addition, UK has a separate document, CAP 715 that deals with an introduction to aviation maintenance human factors to address safety human performance and limitations aspects.

The New Zealand aviation industry recognizes human factors and acknowledges their role in setting quality and safety. Many organizations in New Zealand have indeed established mature and effective quality and safety management systems. Recognizing the role legislation and developing policies for the establishment of safety in aviation maintenance, the Civil Aviation Authority of New Zealand established a five-year policy dating from 2013-2018.

The plan envisions to address safety management systems implementation strategy in the aviation maintenance industry. The CAA has a dedication becoming a more responsive and result driven organization by increasing overall aircraft system effectiveness, improving sector-wide safe performance and enhancing Improving sector safety performance.

Conclusion

Human factors have continuously gained popularity as the commercial aviation industry realized that human errors, rather than mechanical failure accounted for the most of aviation accidents and incidents. The study of Human factor science is a multidisciplinary field encompassing contributions from engineering, statistics, operations research, psychology, industrial design, and anthropometry. For instance, human errors continue to claim lives of innocent passengers through the worldwide airline accidents reported.

The government in collaboration with all economic sectors as well non-governmental and private organizations should invest heavily in addressing human factors that result in human errors. However, it is the responsibility of everyone in the workplace including the technicians in the aviation maintenance to adhere to all guidelines set in ensuring safety. Communication is a vital component of ensuring safety within the industry. The airline companies should adopt the most current technological advancements to foster communication. In addition, the aviation industry must adhere to the set guideline of the Occupational Health and Safety Act while ensuring that they establish collaboration and the best levels of the recommended teamwork.

Conclusion 100 words

Recommendations 100 words

References

Federal Aviation Administration. (2014). *Aviation Maintenance Technician Handbook.* Jebel Ali Free Zone, Dubai. Mepcount Media LLC.

Hertz, Harry S. (2004). Criteria for performance excellence. Baldridge national quality program. National Institute of Standards and Technology. Technology Administration. Department of Commerce.

Hobbs, A. (December, 2008). *An Overview of Human Factors in Aviation Maintenance. TSB Transport Safety Report.* Aviationn Research and Analysis. Retrieved from: ttp://www.atsb.gov.au/media/27818/hf\_ar-2008-055.pdf

Jacko, J. A. (2009). *Human-Computer Interaction. Interacting in Various Application Domains: 13th International Conference, HCI International 2009, San Diego, CA, USA, July 19-24, 2009, Proceedings, Part IV*. Berlin, Heidelberg: Springer Berlin Heidelberg

**National Transport Safety Board**. (26th April, 2011). *NTSB Annual Aviation Statistics Report.* Federal Research News.Retrieved from: http://www.trb.org/SafetyHumanFactors/Blurbs/165258.aspx

O'Connor, P. E., & Cohn, J. V. (2010). *Human performance enhancement in high-risk environments: Insights, developments, and future directions from military research*. Santa Barbara, Calif: Praeger.

Salas, E., & Maurino, D. E. (2010). *Human factors in aviation*. Amsterdam: Academic Press/Elsevier.

Shappell.et al. (2006). *Human Error and Commercial Aviation Accidents: A Comprehensive, Fine-Grained Analysis Using HFACS.* Washington, DC. Federal Aviation Administration.Retrieved From *http://www.faa.gov/data\_research/research/med\_humanfacs/oamtechreports/2000s/media/200618.pdf*

 Spielberger, C. D. (2004). *Encyclopedia of applied psychology: Vol 1*. Oxford: Elsevier Ltd.

Wise, J.A., Hopkin, D., & Garland, D.J. (2009). *Handbook of Aviation Human Factors: Human Factors in Transportation.* Boca Raton, Florida. CRC Press.

NOPSEMA. (2015). *A safe environmentally Responsible Australian offshore petroleum industry.* Common Wealth of Australia. Retrieved from: http://www.nopsema.gov.au/resources/human-factors/