Avoiding the Maintenance Dirty Dozen: A Case Study on Risk and Safety Practices Implemented for Technical Courses in FDSA

Celine Zapata [1], Cristephanie Villanueva[1], Karl Matthew Tan[1], Salvador JR Loria[2]

[1]*Student, Graduate School, Nueva Ecija University of Science and Technology, Cabanatuan, Nueva Ecija, Philippines.*

[2]*Subject Adviser, Department of Engineering Management, Graduate School, Nueva Ecija University of Science and Technology, Cabanatuan, Nueva Ecija, Philippines.*

Corresponding Author: tankarl122@gmail.com

Abstract: The twelve most common human errors or "Dirty Dozen" in Aviation Maintenance has been the major priority in Human Factors Training in the Aviation Industry. The aim of this quantitative study is to assess the risk and safety practices of the FDSA Aviation College of Science and Technology by gathering and analyzing the insights and experience of the students within the organization in relation to the human factor errors that are prevalent in the industry that is applicable to their training. The results within the paper also includes the recommendations for practice and for future researches of local ATOs in their improvement of their Safety Management within the organization.

Key Words: — ***Aircraft Mechanic, Avionics Technician, Hazards, Human Factors, Maintenance Dirty Dozen, Safety.***

I. INTRODUCTION

According to the International Civil Aviation Organization or ICAO (2022), safety is a core value that offers the rapid and dependable air services helped to make commercial aircraft the safest way to travel the world [1]. Safety is a condition of being protected from danger and unlikely to cause risk and injury.

Aviation is an industry where safety is one of its most significant priorities. Whether it is a helicopter, an airplane, or a hot air balloon, the proper maintenance of these different types of aircraft is important to maintain their airworthiness. In order to perform these maintenance, human resources, such as mechanics, avionics, and engineers are needed. With the addition of human resources, the human factors must therefore be considered in order to promote and improve the safety environment of the industry.

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In light of this, the industry has required the various approved training organizations (ATO) to develop the safety habits and culture of future and current maintenance personnel.

According to several studies, more than 80% of aviation accidents have been attributed to human errors at varying levels. Human errors are inevitable, and certain conditions allow these errors to happen. Some human factors in aviation that can lead to errors are so common that they are regularly included in aircraft maintenance technology and aviation electronics technology training courses. These errors are narrowed down into 12, which is often called Maintenance Dirty Dozen.

The role of approved training organizations is to develop airmen who are not only skilled and knowledgeable on the concepts, principles, and theories regarding aircraft and their maintenance procedures. They are expected to instill the safety practices of the industry in the maintenance personnel, in hopes of preventing these dirty dozen components from happening in the workplace.

FDSA Aviation College of Science and Technology, Inc., or FDSA, is an approved training organization that offers technical courses, which are Aircraft Maintenance Technology (AMT) and Aviation Electronics Technology (AET). Students

of this program will be future mechanics and avionics of the industry.

For this study, the researchers aim to assess the risk and safety practices implemented by FDSA by analyzing if the students of AMT and AET courses avoid the maintenance dirty dozen.

II. Maintenance Dirty Dozen

According to ICAO (1989), human factors is a concept that describes how individuals interact with their surroundings, including their connections with machines, procedures, and other people as well as their living and working conditions. [2]. Human factors focus on how the work affects the worker. Transport Canada determined twelve human factors that degrade people's ability to perform effectively and safely. These twelve were adapted by the aviation industry and is collectively known as Maintenance Dirty Dozen or just dirty dozen.

The dirty dozen is described as the 12 most common possible causes for any maintenance personnel to make errors during work. These errors may occur because of one or more causes from these following: lack of communication, complacency, lack of knowledge, distraction, lack of teamwork, fatigue, lack of resources, pressure, lack of assertiveness, stress, lack of communication, and norms [3].

According to Federal Aviation Administration, or FAA (2021), it is important to know the dirty dozen, how to recognize their symptoms, and most importantly, know how to avoid or contain errors produced by the dirty dozen. Understanding the interaction between organizational, work group, and individual factors that may lead to errors and accidents, AMTs can learn to prevent or manage them proactively in the future [4].

The following are the dirty dozen, their meaning, how to mitigate this safety hazards in accordance with the safety handbook published by the FAA (2021) and an article by Spartan College (2020):

2.1 Lack of Communication:

This item tops the Dirty Dozen because it's so critical. Sometimes verbal directions aren't conveyed properly, are incomplete, or are misinterpreted by the recipient [5]. Communication occurs between the AMT and many people like the management, pilots, parts suppliers, and aircraft servicers. Each exchange holds the potential for misunderstanding or omission. But communication between mechanics and avionics may be the most important of all.

Lack of communication between technicians could lead to a maintenance error and result in an aircraft accident. To avoid communication problems, the approved steps of a maintenance procedure must be signed off by the technician doing the work as it is performed. Continuing a job that has been started by someone else should only occur after a face-to-face meeting of technicians. The applicable paperwork should be reviewed, the completed work discussed, and attention for the next step should be drawn. Absence of either a written or oral turnover serves as warning that an error could occur [4].

2.2 Complacency

When people perform the same tasks routinely, they may become over-confident, thinking the work is too easy. Consequently, they become less vigilant about checking for mistakes [5]. Complacency is a human factor in aviation maintenance that typically develops over time. As a technician gains knowledge and experience, a sense of self satisfaction and false confidence may occur. A repetitive task, especially an inspection item, may be overlooked or skipped because the technician has performed the task a number of times without ever finding a fault. In order to avoid this, a technician must train oneself to expect to find the fault that created the inspection item in the first place. He or she must stay mentally engaged in the task being performed. All inspection items must be treated with equal importance, and it must never be assumed that an item is acceptable when it has not been inspected. A technician should never sign for any work that has not been performed. Prior to the pen touching the paper for a signature, the technician should read the item before signing and confirm it has been performed [4].

2.3 Lack of Knowledge

Not having the necessary training or ability to inspect and maintain aircraft will surely lead to errors. Having the proper knowledge is critical to performing the proper tasks [5]. A lack of knowledge when performing aircraft maintenance can result in a faulty repair that can have catastrophic results. Differences in technology from aircraft to aircraft and updates to technology and procedures on a single aircraft also make it challenging to have the knowledge required to perform airworthy maintenance. The way to mitigate this is to ensure that all maintenance must be performed to standards specified in approved instructions. These instructions are based on knowledge gained from the engineering and operation of the aircraft equipment [4].

2.4 Distraction

Distractions occur when anything other than the task at hand vies for your attention. Distractions are included in the Dirty Dozen because they make you more likely to forget things and lose track of your workflow [5]. A distraction while performing maintenance on an aircraft may disrupt the procedure. When work resumes, it is possible that the technician skips over a detail that needs attention. It is estimated that 15 percent of maintenance related errors are caused by distractions. To avoid distractions during work, the technician must recognize when attention to the job at hand is being diverted and assure that work continues correctly [4].

2.5 Lack of Teamwork

When team members aren't on the same page about shared goals or don't respect and trust each other, they will be hindered in getting the job done [5]. A lack of teamwork may also contribute to errors in aircraft maintenance. It is closely related to lack of communication, as teamwork is required in aviation maintenance in many instances. Sharing of knowledge between technicians, coordinating maintenance functions, turning work over from shift to shift, and working with flight personnel to troubleshoot and test aircraft are all are executed better in an atmosphere of teamwork [4].

2.6 Fatigue

Among the most prevalent maintenance human factors is fatigue. When employees are exhausted — mentally or physically —their work performance suffers [5]. Fatigue is a major human factor that has contributed to many maintenance errors resulting in accidents. Fatigue can be mental or physical in nature. Emotional fatigue also exists and effects mental and physical performance. The best remedy for fatigue is to get enough sleep on a regular basis [4]. To avoid excessive fatigue, look for and address signs of fatigue in yourself and others.

2.7 Lack of Resources

Mistakes are virtually guaranteed if you're short-staffed or don't have the time, parts, or equipment you need to successfully complete your work [5]. A lack of resources can interfere with one's ability to complete a task because there is a lack of supply and support. Low quality products also affect one's ability to complete a task. Aviation maintenance demands proper tools and parts to maintain a fleet of aircraft. Technical documentation is another critical resource that can lead to problems in aviation maintenance. When trying to find out more about the task at hand or how to troubleshoot and repair a system, often the information needed cannot be found because the manuals or diagrams are not available [4]. This factor is mostly caused by the organization and they are the one who should rectify this problem.

2.8 Pressure

Whether the pressure is real or perceived, the implications are the same. When people feel as though they're always expected to perform at an extraordinarily high level, they're more likely to make errors [5]. Organizations must be aware of the time pressures that are put on aircraft mechanics and help them manage all of the tasks that need to be completed so that all repairs, while done in a timely manner, are completed correctly with safety being the ultimate goal. Sacrificing quality and safety for the sake of time should not be tolerated or accepted. In an effort to combat self-induced pressure, technicians should ask for help if they feel overwhelmed and under a time constraint to get a repair fixed. Another method is to have someone check the repair thoroughly to ensure that all maintenance tasks were completed correctly [4].

2.9 Lack of Assertiveness

Team members sometimes fail to speak up or document their concerns when they see something has been done incorrectly or instructions aren't clear [5]. It is important for maintenance personnel to be assertive when it pertains to aviation repair rather than choosing or not being allowed to voice their concerns and opinions. The direct result of not being assertive could ultimately cost people their lives as the employees become aware of behavior styles and understand their own behavior, they see how they unwittingly contribute to some of their own problems and how they can make adjustments. Assertive behavior may not be a skill that comes naturally to every individual, but it is a critical skill to achieve effectiveness [4].

2.10 Stress

Whether it's caused by workplace issues or personal struggles, stress can have a negative impact on job performance [5]. Aviation maintenance is a stressful task due to many factors. Aircraft must be functional and flying in order for airlines to make money, which means that maintenance must be done within a short time frame to avoid flight delays and cancellations. The ultimate stress of aviation maintenance is knowing that the work they do, if not done correctly, could result in tragedy. The causes of stress are referred to as stressors. They are categorized as physical, psychological, and

physiological stressors. Following, is a list of each and how they may affect maintenance.

- **Physical Stressors**. Physical stressors add to the personnel's workload and make it uncomfortable for him or her in their work environment.
- **Psychological Stressors**. Psychological stressors relate to emotional factors, such as a death or illness in the family, business worries, poor interpersonal relationships with family, co-workers, supervisors, and financial worries.

People cope with stress in many different ways. Specialists say that the first step is to identify stressors and the symptoms that occur after exposure to those stressors. Other recommendations involve development or maintenance of a healthy lifestyle with adequate rest and exercise, a healthy diet, limited consumption of alcoholic drinks, and avoidance of tobacco products [4].

2.11 Lack of Awareness

Failure to assess a situation and understand what should be done can lead to costly mistakes [5]. Lack of awareness is defined as a failure to recognize all the consequences of an action or lack of foresight. In aviation maintenance, it is not unusual to perform the same maintenance tasks repeatedly. After completing the same task multiple times, it is easy for technicians to become less vigilant and develop a lack of awareness for what they are doing and what is around them. Each time a task is completed it must be treated as if it were the first time [4].

2.12 Norms

Playing by the expected but unwritten rules of workplace culture sometimes contributes to poor attitudes and habits, causing errors and mistakes [5]. Norms have been identified as one of the dirty dozens in aviation maintenance and a great deal of anecdotal evidence points to the use of unsafe norms on the line. The effect of unsafe norms may range from the relatively benign, such as determining accepted meeting times, to the inherently unsafe, such as signing off on incomplete maintenance tasks. Any behavior commonly accepted by the group, whether as a standard operating procedure (SOP) or not, can be a norm. Supervisors need to ensure that everyone adheres to the same standards and not tolerate unsafe norms [4].

According to a study by Samad et al. (2018), Based on the statistics obtained from the survey conducted by the researcher, human errors are concluded as the major cause of accident in hangars and workshop maintenance.

It can be said that human error related to Dirty Dozen plays an important role and it is one of the effective ways to reduce the accidents in hangar and workshop maintenance. It is essential that every student who is working in hangar and workshop understands that no matter how simple the task is, if it is not done properly, the results can be serious. It is very important on high technology and complex system of the aircraft [6].

III. METHODOLOGY

The researcher used a quantitative approach to learn and assess the risk and safety practices implemented for technical courses in FDSA by focusing on the Maintenance Dirty Dozen. The researchers utilized deductive reasoning in which the researcher defined the study's purpose, collected data through electronic form and questionnaires and the findings when statistical treatments were applied. The data collection of this paper was executed between the months of September and November of the 2022. All information through surveys were gathered from the 1st Year to 4th Year Aircraft Maintenance Technology and Aviation Electronics Technology students of FDSA Aviation College of Science and Technology, Inc.

The researchers sent a formal request to the Dean of Academic Affairs of FDSA to conduct the study. The researcher created 2 sets of questionnaires. The first set is for the student, and this assesses whether the students identify the likelihood of dirty dozen to appear during their technical course. The second set of questionnaires is for the instructors. This 2nd set of questionnaires confirms the data gathered from the first set of questionnaires. Both sets of questionnaires also probe the respondents of the dirty dozen mitigation techniques their organization practices and what techniques should be incorporated or prioritized.

The questionnaire was then distributed to participants via messenger and e-mail. The respondents were informed of the critical nature of their response to the study and clarifies certain words so that respondents can complete the questionnaire fully aware of their responsibilities as the study's subject. The researcher urged the respondents to be very honest in answering the questionnaire. Following the respondents' responses to the questionnaire, the researcher gathered, summarized, analyzed, and evaluated the data in conjunction with the representative's observation for interpretation. The researcher generated the results, conclusions, and suggestions based on the data.

The researchers used a 5-point Likert Scale for the survey on the students. To make the results easier to interpret, the

researchers used Table 1.1 below to identify the likelihood of the dirty dozen from happening during their school activities.

Table 1.1 Interpretation of the Five-point Likert Scale for the Student's Data

Likert Scale	Interval	Description
1	1.00-1.80	Very Unlikely
2	1.81-2.60	Unlikely
3	2.61-3.40	Neutral
4	3.41-4.20	Likely
5	4.21-5.00	Very Likely

IV. RESULTS AND DISCUSSION

The first part of the results is data retrieved from 100 AMT and AET students of FDSA Aviation College of Science and Technology, Inc. Table 2.1 below shows the likelihood of dirty dozen to appear during technical courses.

Table. 2.1 Assessment on the Likelihood of Dirty Dozen to Appear during Technical Courses

	Mean	Interpretation	Range	Mode
Assessment on the Likelihood of Dirty Dozen to Appear During Technical Courses	**3.63**	**Likely**	**1-5**	
1. Lack of Communication	3.45	Likely	1-5	1
2. Complacency	3.93	Likely	1-5	3
3. Lack of Knowledge	3.66	Likely	1-5	5
4. Distraction	4.08	Likely	1-5	5
5. Lack of Teamwork	3.57	Likely	1-5	5
6. Fatigue	3.66	Likely	1-5	4
7. Lack of Resources	3.76	Likely	1-5	4
8. Pressure	3.49	Likely	1-5	5
9. Lack of Assertiveness	3.34	Neutral	1-5	3
10. Stress	3.54	Likely	1-5	3
11. Lack of Awareness	3.65	Likely	1-5	5
12. Norms	3.44	Likely	1-5	3

Table 2.1 above shows the descriptive statistics of the variables in determining the frequency of hazards experienced during their technical courses. To interpret the results, Table 1.1 was used. Distraction and Complacency placed at the top with the highest frequency or likelihood to appear during the courses and Lack of Assertiveness and Norms were the lowest among the 12 components. The data shows that the overall likelihood of dirty dozen to appear during technical courses has a mean of 3.63, this can be interpreted as a "likely" result. This is further supported by observing all the components, as the said items have a mean that is between 3.41-4.20.

Table 2.2 Components of Dirty Dozen that caused safety hazards and needs action based on the perception of instructors

Components of Dirty Dozen	Cause Safety Hazards	Needs Immediate Attention
1. Lack of Communication	100%	86%
2. Complacency	100%	86%
3. Lack of Knowledge	100%	71%
4. Distraction	86%	71%
5. Lack of Teamwork	86%	71%
6. Fatigue	86%	57%
7. Lack of Resources	71%	29%
8. Pressure	86%	57%
9. Lack of Assertiveness	57%	43%
10. Stress	86%	71%
11. Lack of Awareness	71%	57%
12. Norms	71%	43%

The data above demonstrates the significance of the dirty dozen components that can cause safety hazards during school activities. Table 2.2 also shows which component of the dirty dozen needs immediate attention from the management of the school based on the perception of the instructors of FDSA. Based on the table above, lack of communication, complacency, and lack of knowledge are the leading causes of

safety hazards, while lack of communication and complacency needs immediate action from the instructors' data.

Table 2.3 Components of Dirty Dozen Ranked in accordance to Occurrence

Ranking of Occurrence	Dirty Dozen
12 - Most Likely to Occur	Lack of Communication
11	Complacency
10	Lack of Knowledge
9	Distraction
8	Lack of Teamwork
7	Lack of Resources
6	Pressure
5	Lack of Awareness
4	Lack of Assertiveness
3	Stress
2	Norms
1 - Least Likely to Occur	Fatigue

Table 2.3 shows the consolidated ranking of occurrence during the technical courses. This data is based on the data collected from both student and instructor respondents. The top 3 dirty dozen which are likely to occur is lack of communication, complacency, distraction, and lack of knowledge. This supports the data on previous tables which confirms that among the 12 components, Lack of Communication and Knowledge, Complacency and Distraction are among the top factors to occur and should be dealt with immediately to reduce human errors in the organization.

Table 2.4 Practices Needed to be Applied and Improved during Technical Courses

Practices to be Applied	**% of Student Respondents**	**% of Instructor Respondents**
Proper Signages	100%	71%
Safety Reminders	100%	57%
Safety Trainings	100%	71%
Availability of PPE	100%	71%
Auditing of Laboratory Activities	84%	57%
Proper Communication of Tasks	93%	57%
Banning of Distractors	83%	43%
Posting of Incident Reports	100%	71%
Application of Theory	100%	43%
Creating a Checklist	100%	71%

The last section of the survey is shown in Table 2.4. It shows the practices that are needed to be implemented/improved in order to develop the safety standards of the students and prevent human errors of the organization. The students' and instructors' perception of recommended practices prioritizes the addition of proper signages, safety trainings, utilization of proper PPE, Incident reports, and checklists.

V. Conclusion

Human error is one of the leading causes of accidents in the aviation industry. The aviation industry has categorized the human errors into 12 different components which are collectively called as the Maintenance Dirty Dozen. Based on the data and literature analyzed, the researchers conclude that the dirty dozen does appear during their technical courses and that the organization should develop their safety practices to reduce accidents. The data also highlights that lack of communication, knowledge, complacency, and distraction are among the leading causes of safety hazards occurring within FDSA and requires immediate actions. The researchers recommend to apply the recommended practices such as the proper utilization of safety documents, signages, and checklists, and maximize the safety training and use of PPEs to prioritize the safety and limit the accidents for all members within the organization. Further recommendations include an in-depth and directed study to the effectivity of application of the recommended practices within the organization and the recalibration of prioritized components once mitigated.

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