



Safety culture among engineers and technicians: A case study from an aircraft maintenance facility in Lagos

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Abstract

Background: The exposure of engineers and technicians to several categories of work place hazards in the aircraft hangar and their impact on overall flight safety cannot be ignored. Therefore, this study investigated the safety conditions within the hangar of the Nigerian Air Force Aircraft Maintenance Depot in Lagos, with a specific focus on evaluating the level of awareness and compliance of engineers and technicians regarding established safety measures.

Method: This study adopted a descriptive cross-sectional research design. The population of the study comprised entire depot strength which currently stood at 179 with 76 (42.4%) of these being core engineering and technical staff. The remaining 103 members of staff are mainly support staff consisting general duty clerks, secretaries, air traffic controllers, meteorologists, firefighters, loadmasters, supply and finance personnel. The entire 76 Engineers and technicians in this unit were the intended participants. The study adopted a purposive sampling technique and entire 76 Engineers and technicians consisted of the sample size. Data collection was conducted using self-administered questionnaires in English, comprising four major sections. Data analysis was conducted using Epi Info statistical software version 3.5.1 (2008) and the WinPepi statistical package. The results are presented in the form of tables, pie charts, and bar charts to facilitate interpretation.

Results: Finding showed that respondents had a reasonably good knowledge of hazards present in the aircraft hangar. This outcome is likely the influence of frequent training activities and the formal technical education received. Also, respondents had a varied attitude towards observing safety signs in the hangar and more than half of the respondents agreed that there were provided with some form of personal protective equipment.

Conclusions: The study concluded that there was a high level of awareness regarding potential hazards in the hangar environment. Noise was identified as the most commonly recognized hazard, followed by dust, lubricants, and oil residues on the hangar floor. Safety knowledge among personnel was deemed satisfactory, with the majority acquiring information through both personal experience and routine safety briefings conducted by the depot safety officer. Attitudes toward safety were generally positive, with over half of the respondents demonstrating a strong commitment to consistently observing safety signage within the workplace.

Recommendations: This study recommended amongst others that Personnel should be supplied with PPE tailored to the specific hazards associated with their respective roles and areas of specialization. This ensures optimal protection and enhances compliance with safety protocols.

Keywords: Safety culture, engineers and technicians, aircraft maintenance, occupational safety

Introduction

The association between occupational activities and illness was first explored by Hippocrates. Centuries later, Bernardino Ramazzini, in his seminal work *Diseases of Workers*, documented a wide range of ailments affecting individuals across more than fifty occupational settings. Given that his treatise was published in the early 18th century, it is unsurprising that it does not address the aviation industry. In the early 20th century, Alice Hamilton, a professor at Harvard School of Public Health, conducted field investigations across industrial sites in the eastern United States. Her work involved systematic documentation of occupational conditions and the formulation of recommendations aimed at improving worker welfare (Dehart & Davis, 2006)^[1].

More recently, Dhenin, a prominent figure in aviation medicine in the United Kingdom, emphasized that aviation medicine constitutes a specialized branch of occupational medicine. His contributions highlighted the unique hazards inherent in aviation and underscored the necessity of adapting human physiology to the industry's demanding environment. Since the inception of air transportation, accident prevention has been a critical concern. However,

safety efforts have predominantly focused on flight operations, often at the expense of addressing the working conditions of ground personnel, including engineers and technicians. This emphasis is understandable given the potentially catastrophic consequences of in-flight accidents. Nonetheless, the exposure of ground personnel to various occupational hazards within aircraft hangars has significant implications for overall flight safety and warrants equal attention (McFarland, 2002)^[7].

The aviation workplace encompasses a broad array of materials, processes, and operations similar to those found in general manufacturing. These include aircraft repair and maintenance activities such as drilling, riveting, fastening, welding, painting, aluminum layout, template work, sub-assembly, fuselage fabrication, engine and propeller installation, turbine and wing section placement, electronic and avionics equipment handling, and inspection and repair of tools and machinery.

Despite advancements in safety protocols, ground accident rates in the aviation sector remain relatively high. While the complexity of modern aircraft is widely acknowledged, the extent of hazards associated with their servicing and repair is less understood outside the industry. Minor injuries

frequently occur due to foreign bodies in the eye, hand lacerations or abrasions, sprains, and back injuries. Fires in maintenance shops are common, and serious incidents—including permanent injuries or fatalities—have resulted from falls off aircraft wings or accidental contact with rotating propellers. These examples illustrate the severity and diversity of risks present in aircraft maintenance environments.

Negligence by ground maintenance crews can also precipitate major flight accidents. Therefore, flight safety is intrinsically linked to ground safety, and a comprehensive safety program is essential to safeguard both airborne operations and the wellbeing of ground personnel. Several factors contribute to the hazardous nature of aircraft hangars. For instance, the requirement for rounded and polished exterior surfaces increases the risk of slips and falls when personnel work on upper sections of aircraft. Fixed projections such as propellers and aials, which cannot be easily repositioned, pose frequent “striking-against” hazards.

Hangars also present inherent fire and explosion risks due to the presence of volatile fuels, high-pressure gases (e.g., oxygen, nitrogen, carbon dioxide), and toxic solvents and paints used in degreasing and cleaning. Electrical malfunctions or sparks from power tools and welding equipment further exacerbate these dangers, threatening both personnel and equipment. Even with well-designed maintenance systems, aircraft often contain numerous accessory components within confined spaces. Simultaneous servicing of these components can lead to various contact hazards. Additional risks include exposure to intense light (e.g., from welding), loud or continuous noise, extreme temperatures, moving machinery, vehicular traffic, and vibration.

The Nigerian Air Force Aircraft Maintenance Depot in Lagos is responsible for third- and fourth-line maintenance of military transport aircraft, as well as the overhaul of turboprop engines. Its primary focus is the maintenance of the Hercules C-130, a fixed-wing tactical transport aircraft. This aircraft plays a critical role in the rapid deployment of troops during periods of national unrest, as demonstrated during the Boko Haram insurgency, when reinforcements from the 3rd Armored Division of the Nigerian Army were mobilized to address the crisis in Bauchi. Additionally, the C-130 facilitates the swift delivery of equipment to and within operational zones, as evidenced during the ECOMOG missions in Liberia and Sierra Leone. Given the operational demands of this aircraft, engineers and technicians stationed at the depot may be required to accompany it on deployment missions. Such assignments can significantly increase their exposure to occupational hazards, particularly when working under suboptimal or austere field conditions. It is against this background that the present study strives to investigate the hanger at the Nigerian Air Force Aircraft maintenance Depot, Lagos and assess the level of awareness and compliance of the Engineers/Technicians to safety measures.

Aim and Objectives of the Study

This study aimed to examine the safety conditions within the hangar of the Nigerian Air Force Aircraft Maintenance Depot in Lagos, with a specific focus on evaluating the level of awareness and compliance of engineers and technicians

regarding established safety measures. The objectives of the study were:

1. To determine the level of knowledge of engineers/technicians to safety measures in the NAF Aircraft maintenance depot Lagos.
2. To assess the attitude of engineers/technicians to work place hazards at the NAF Aircraft maintenance depot, Lagos.
3. To assess the utilization of personal safety equipment/devices by Engineers/technicians in the NAF Aircraft maintenance depot, Lagos

Materials and Methods

This study was conducted at the 401 Aircraft Maintenance Depot (401 ACMD), located in Ikeja, Lagos, South-West Nigeria (latitude 6.6°N, longitude 3.3°E). The facility is bordered by the Murtala Mohammed International Airport to the north, the presidential wing and domestic terminal to the west, and other Nigerian Air Force units to the east and south. Established in 1975 for first- and second-line maintenance of the C-130H Hercules and other aircraft, the depot was later upgraded to perform in-depth checks on medium- and heavy-duty Nigerian Air Force aircraft. It was subsequently renamed 2 Engineering Aircraft Maintenance Depot, then 2 Engineering Group in 1985, and finally designated as 401 ACMD in 2000. This study adopted a descriptive cross-sectional research design. The population of the study comprised entire depot strength which currently stood at 179 with 76 (42.4%) of these being core engineering and technical staff. The remaining 103 members of staff are mainly support staff consisting general duty clerks, secretaries, air traffic controllers, meteorologists, firefighters, loadmasters, supply and finance personnel. The entire 76 Engineers and technicians in this unit were the intended participants. The study adopted a purposive sampling technique and entire 76 Engineers and technicians consisted of the sample size.

Data collection was conducted using self-administered questionnaires in English, comprising four major sections. The instrument primarily featured closed-ended questions, with a limited number of open-ended items to allow for unbiased expression of respondents' views. The questionnaires were designed to generate data aligned with the three objectives of the study.

Section One captured demographic and social characteristics, including age, sex, marital status, religion, ethnic group, employment category, and educational level.

Section Two focused on occupational information, such as area of specialization, duration of practice in the current role, and history of deployments outside the unit.

Section Three assessed personnel knowledge and attitudes toward health and safety within the hangar. This included questions on hazard exposure, its potential consequences, and awareness of safety signs and procedures.

Section Four evaluated safety practices among workers, with particular emphasis on the use or non-use of personal protective equipment and emergency response protocols.

A pilot test of the questionnaire was conducted with eight aircraft technicians from Dana Airlines, a private aviation company utilizing the Air Force hangar for first-line maintenance. This pre-test aimed to evaluate readability, clarity, and completion time. Based on feedback, minor adjustments were made to improve comprehension of selected question stems. The finalized questionnaires were administered during a scheduled training exercise held in

the technicians' crew room at the depot. Attendance at such exercises is typically mandatory due to the regimented nature of military operations. Most participants completed and returned the questionnaires on-site. For those absent, follow-up visits were made to ensure participation, except in cases involving personnel on foreign assignments, maternity leave, or medical leave.

Data analysis was conducted using Epi Info statistical software version 3.5.1 (2008) and the WinPepi statistical package. The results are presented in the form of tables, pie charts, and bar charts to facilitate interpretation. Statistical significance was assessed at a 95% confidence level, with a threshold p-value of 0.05. Comparative analysis of variables was performed using the Chi-square (χ^2) test and Fisher's exact test, as appropriate. In adherence to established ethical guidelines and to ensure the integrity of the research process, several measures were implemented. Confidentiality was maintained by omitting personal identifiers from the questionnaires; instead, numerical codes were used to distinguish individual responses. Appropriate rapport was established with both management and staff, and care was taken to avoid any breach of protocol or disruption to operational activities within the depot. Additionally, every effort was made to minimize any potential stress or inconvenience to participants resulting from their involvement in the study.

Results and Findings

Table 1: Distribution of Workers by Employment Category (N=71)

Employment Category	Frequency	Percentage (%)
CPL below	5	7.0
SGTs and WOs	55	77.5
PLT OFFR to SQN LDR	5	7.0
WG CDR and above	6	8.5
Total	71	100.0

Table 3: Occupational Injuries Suffered in the Work Place That Required Hospital Visit (N=71)

Conditions That Required Hospital Visit	Frequency	Percentage (%)
Low back pain from bending and lifting weights	10	14.1
Burns	1	1.4
Gradual hearing loss	5	7.2
Foreign objects or chemicals in the eye	3	4.2
Breathing problems from engine fumes/chemicals	6	8.5
Trips and falls	2	2.8
Sprains	2	2.8
Cuts and bruises	16	22.5
Skin allergy from chemical contact	2	2.8
Numbness in fingers and toes	0	0
Others	1	1.41

(Multiple responses allowed)

Cuts and bruises accounted for the highest number of hospital visits (22.5%), followed by back pain with 14.1%. Breathing issues from inhalation of fumes and chemicals accounted for 8.5% while hearing problems were

responsible for 5% of hospital visits. Trips and falls and sprains accounted for 2.8% each while skin allergy from chemical contact gave rise to another 2.8% of visits. Burns accounted for the least visits at 1.4%.

Table 2: Respondents Knowledge on Possible Hazards in the Hangar (N=71)

Hazard	Frequency	Percentage (%)
Heat	45	63.4
Chemical agents	34	48.6
Radiation	43	60.6
Lubricants and oils on hangar floor	50	70.4
Dust	55	77.5
Fire	29	40.8
Engine Fumes	44	62.0
Noise	68	97.1
Working in cramped spaces	37	52.1
Vibration	44	62.0
Working at heights (Up To 4ft Above Ground)	42	59.2

(Multiple responses allowed)

Table 2 shows some of the possible hazards present in the hangar environment and respondents' knowledge of these hazards. The highest acknowledged hazard among respondents was noise (97.1%) followed by dust with 77.5%. Lubricants and oils on the hangar floor were the third highest identified hazard at 70.4%. Heat was 63.4%, engine exhaust fumes and radiation were both 62.0%, and working at heights up to 4 feet above ground level was 59.2%. Other hazards acknowledged were working in cramped spaces (52.1%), exposure to chemical agents (48.6%), and fire, which was the least acknowledged at 40.8%.

Table 4: Attitude to Regular PPE Use in the Hangar (N=71)

Regular PPE Use	Frequency	Percentage (%)
Agree	6	8.5
Strongly Agree	62	87.3
Disagree	0	0
Strongly Disagree	3	4.2
Undecided	0	0
Total	71	100.0

In terms of the attitude of respondents towards regular PPE use in the hangar, the majority (87.3%) strongly agree that PPEs should be used at all times while 6% of them merely

agreed.3% strongly disagreed while none of the respondents disagreed or were undecided.

Table 5: Attitude to Observance of Safety Signs in the Hangar (N=71)

Always Observe Safety Signs in Place	Frequency	Percentage (%)
Agree	21	29.5
Strongly Agree	44	60.9
Disagree	3	4.2
Strongly Disagree	1	1.2
Undecided	2	4.2
Total	71	100.0

Concerning the observance of safety signs in the hangar, respondents' attitude varied. 44 of them (60.9%) strongly agreed that safety signs should always be observed,

21(29.5%) agreed, while 2 (4.2%) were undecided. 3 (4.2%) on the other hand disagreed while only 1 individual (1.2%) strongly disagreed.

Table 6: Attitude of Workers to House Keeping Responsibility (N=71)

Only Cleaners Should Clear Hangar Floor of Oil, Water and Debris	Frequency	Percentage (%)
Agree	5	7.0
Strongly Agree	13	18.3
Disagree	32	45.1
Strongly Disagree	15	21.1
Undecided	6	8.5
Total	71	100.0

Most of the respondents (45.1%) disagree to only cleaners being responsible the removal of spilled lubricants and other debris from the hangar floor.21.1% strongly disagree,18.3%

strongly agree,8.5% are undecided while the remaining 7% agree.

Table 7: Utilization of Personal Protective Equipment (N=71)

Level of Utilization of Personal Protective Equipment (PPE)	Frequency	Percentage (%)
Never	10	14.1
Rarely	14	19.7
Sometimes	16	22.5
Very Often	13	18.3
Always	18	25.4
Total	71	100.0

Even though more than half of the respondents were provided with some form of personal protective equipment, the frequency of usage varied among them. 18 (25.4%) of the workers used their PPEs always, 13 (18.3%) used theirs

very often and 16 (22.5%) sometimes. On the other hand, 14 (19.7%) rarely used the provided PPEs and 10 (14.1%) never used theirs.

Table 8: Respondents Reasons for not Using PPE (N=71)

Reason for not Using PPE	Frequency	Percent (%)
Overall wrong size	4	5.7%
Ear muffs disturb hearing	2	2.8%
Gloves cause rash	2	5.7%
Goggles disturb vision	1	1.4%
Boots wrong size	0	0%
Gloves limit dexterity	1	1.4%
Helmet uncomfortable	0	0%
Face mask causes irritation	1	1.4%
Face mask disturbs breathing	0	0%
Others	2	2.8%

(Multiple responses allowed)

Table 8 highlights respondents' reasons for failing to use PPEs. Most of those who didn't use the devices weren't provided with any (42.3%). Wrong size of overalls and hand rash from glove usage each accounted for 5.7% of reasons

for non-use.2.8% didn't comply because ear plugs disturbed their hearing whenever they are worn.1.4% of the workers felt hand gloves limited their dexterity and another 1.4% felt face masks cause irritation.

Table 9: Regularity of PPE Use and Occurrence of Medical Problems Due to Hazard Exposure (N=71)

Regularity of PPE Use	Consequences Experienced from Hazard Exposure		Total
	Yes	No	
Always	13(72.2%)	5(27.8%)	18
Never	8(80.0%)	2(20.0%)	10
Rarely	7(50.0%)	7(50.0%)	14
Sometimes	9(56.3%)	7(43.8%)	16
Very Often	5(38.5%)	8(61.5%)	13
Total	42(59.2%)	29(40.8%)	71

$X^2=5.916$, $DF=4$, Fishers $p=0.2147$

Table 9 shows the association between the regularity of PPE use and the experiencing of medical conditions resulting from hazard exposure (e.g. gradual hearing loss, trips and falls, cuts and bruises, burns, irritation etc). Of those who always used their PPEs, 72.2% of them had suffered medical consequences from hazard exposure. 80% of those who never use their PPEs also experienced these consequences. There was no statistically significant association between the regularity of PPE use and experiencing adverse medical consequences from hazard exposure. ($p>0.05$).

Discussion of Findings

Respondents showed a reasonably good knowledge of hazards present in the aircraft hangar. This outcome is likely the influence of frequent training activities and the formal technical education received by the respondents. 97.1% identified noise as a hazard, 77.5% dust, 70.4% recognized the inherent danger of oils and lubricants on the hangar floor and 63% identified heat as a hazard. Exposure to engine exhaust fumes and radiation were also recognized as hazards (62.0% each) and working at heights up to 4 feet above ground level was 59.2%. Other recognized hazards were working in cramped spaces 52.1%, exposure to chemical agents 48.6% and fire which was the least acknowledged as a hazard at 40.8%.

In a similar study which assessed the knowledge of occupational hazards and adherence to safety measures among welders in Kaduna metropolis in northern Nigeria, it was found that the hazard knowledge was quite high as was the case in this study. 77.9% of the welders were aware of one or more workplace hazards. This was positively influenced by educational attainment, age, nature of training and work experience (Sabitu, Iliyasu & Dauda, 2009) [10].

Regarding the nature of occupational injuries sustained in the course of working in the hangar, Cuts and bruises to the hands accounted for the highest number of hospital visits (22.5%), followed by back pain with 14.1%. Back pain was largely due to poor ergonomic practices and lifting of heavy items as was the finding in a study on textile workers. Breathing issues from inhalation of fumes and chemicals accounted for 8.5%, while hearing problems were responsible for 5% of hospital visits. Trips and falls and sprains accounted for 2.8% each while skin allergy from chemical contact gave rise to another 2.8% of visits. Burns accounted for the least visits at 1.4. (Kayumba, Bråtveit, Mashalla, Baste, Eduard & Moen, 2009) [5].

In another study, the most common injuries sustained were cut/injuries to the hands and fingers (38.0%), back/waist pain (19%), arc eye injuries and foreign bodies (17.0%), burns (14.0%), hearing impairment (7.0%), fractures (4.0%) and amputation (1.0%) (Omokhodion, Adeosun & Fajola,

2007) [8]. In both studies, injuries to the hands and fingers had the highest occurrences. This similarity shows the extent of involvement of the hands in the work place and buttresses the need to protect it using utility gloves. The regular use of gloves would have significantly reduced the high level of hand injuries observed among the workers. Other injuries common to both groups are back pain, hearing impairment and burns (Singh, Bhardwaj & Deepak, 2010) [11]. The disparity in the percentages of burns sustained by both groups (welders 14% /aircraft technicians 1.4%) is attributable to the welder’s constant dependence on oxy acetylene flame to get his work done. Another study on work injuries in Botswana also found the same type of injuries to be predominant (Dunlap, 2002) [2].

Concerning the attitude of respondents to observing safety signs in the hangar, respondents’ attitude varied. The majority of the respondents had the right attitudes to safety. 44 of them (60.9%) strongly agreed that safety signs should always be observed, 21(29.5%) agreed, while 2 (4.2%) were undecided. 3(4.2%) on the other hand disagreed while only 1 individual (1.2%) strongly disagreed. This high number of workers with the right attitude to safety seem to be the result of regular safety training programmes. This is however similar to findings in two other studies where workers attitude to safety were satisfactory (Kaufman, *et al.* 2010; Van Ooteghem, 2006) [13].

The highest number of workers got their knowledge of safety from both personal experience and regular briefs from the depot safety officer (64.8%), followed by training day programmes (63.4%). Workers who acquired their knowledge from hand books/safety manuals made up 50.7% and those who learnt on the job 45.1%. 18% learnt from coworkers and the remaining 7% from other sources. The acceptably high level of safety knowledge is expected because 90.1% of all the respondents agreed that they had a regular forum for safety and training instruction organized by the depot authorities. 66% of the workers were however satisfied with the overall safety profile in the hangar. In a similar study, majority of respondents acquired their safety knowledge from formal sources like regular training programmes and manuals. The existing similarities between both studies is possibly due the formal and structured nature of both organizations (Ugur, 2006; Mayer, Flocks & Monaghan, 2010) [6, 12].

More than half of the respondents were provided with some form of personal protective equipment (57.7%), but the frequency of usage varied among them. Of those who were provided with PPEs, 14.1% never used theirs. This is similar to non-use levels among Australian farmers where it was reported that up to 10% of farmers routinely do not use PPEs (Ribak, Cline & Froom, 1999) [9]. The regular use of PPEs did not have any effect on workers who experienced

medical conditions from hazards they were exposed to. There was no statistically significant association between the regularity of PPE use and the occurrence of medical conditions resulting from hazard exposure (e.g. gradual hearing loss, trips and falls, cuts and bruises, burns, irritation etc). Of those who always used their PPEs, 72.2% of them had suffered medical consequences from hazard exposure. 80% of those who never use their PPEs also experienced these consequences. There was no statistically significant association between the regularity of PPE use and experiencing of adverse medical effects from hazard exposure. ($p > 0.05$). This suggests that hazards remain a real and present danger irrespective of how regularly a worker uses his PPEs and that caution be exercised at all times in the work environment. More important is a well-trained employee, who knows how to avoid work place accidents and injuries (Garcia, Boix & Canosa, 2004)^[3].

90% of university graduates in this study knew how to use PPEs correctly, followed by 61.1% of polytechnic graduates and 60.5% of those who attended specialized technical schools. There was however no statistically significant association between educational level and PPE use. Thus, in this study, educational level didn't play a role in the correct use of PPEs. Regarding the duration of time spent in the individual's specialty and the occurrence of accidents, 5% of those in the 0-10 year's bracket had experienced accidents, 23.8% in the 11-20 years bracket and 16.7% in those who have worked for 21 years and above. Experience on the job however does not diminish the occurrence of accidents in the hangar. There was no statistically significant association between years spent in a specialty and the occurrence of accidents.

Conclusion

This study assessed the knowledge, attitudes, and safety practices of hangar engineers and technicians within the Nigerian Air Force aircraft maintenance depot. Findings revealed a high level of awareness regarding potential hazards in the hangar environment. Noise was identified as the most commonly recognized hazard, followed by dust, lubricants, and oil residues on the hangar floor. Safety knowledge among personnel was deemed satisfactory, with the majority acquiring information through both personal experience and routine safety briefings conducted by the depot safety officer. Attitudes toward safety were generally positive, with over half of the respondents demonstrating a strong commitment to consistently observing safety signage within the workplace. Furthermore, safety practices were commendable, as a significant proportion of participants reported regular and correct use of personal protective equipment (PPE). The primary barrier to PPE usage was the inadequate provision of appropriate gear by the depot.

Recommendations

Based on the findings and conclusion of this study, the following recommendations were made

1. Personnel should be supplied with PPE tailored to the specific hazards associated with their respective roles and areas of specialization. This ensures optimal protection and enhances compliance with safety protocols.
2. The manual lifting of heavy aircraft parts should be actively discouraged. Instead, the use of mechanical

lifting aids such as cranes and hoists should be promoted to reduce the risk of musculoskeletal injuries.

3. All workers should receive basic first aid training to enable prompt response to workplace injuries. Additionally, fully equipped first aid kits should be made available in every department to support immediate care.
4. The consistent and correct use of available PPE should be strictly enforced across the depot and supervisory personnel should monitor compliance and address lapses promptly.
5. Workers exposed to elevated noise levels should undergo regular audiometric evaluations to monitor hearing health. Furthermore, the depot should establish a comprehensive Hearing Conservation Program to mitigate long-term auditory risks.

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