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Domestic Helicopter Accident Analysis using HFACS & Dirty Dozen

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Abstract

Safety can be defined as being maintained or reduced to a level below which the possibility of human or physical harm can be tolerated through continuous identification of risks and safety risk management. FAA, EASA, IATA and Boeing, major organizations that conduct research and analysis for aviation safety around the world, report that about 70 percent of aviation accidents are caused by human factors, which have led to a surge in interest in human factors-induced accident prevention activities around the world. As part of this purpose, the FAA in the U.S. is raising awareness among aviation workers by publicizing the 12 human errors (Boeing, 2016), which account for the largest part of aviation accidents under the theme of Dirty Dozen, to prevent aviation accidents. Therefore, based on the domestic helicopter accidents reported to the Air Railroad Accident Investigation Committee from 2007 until recently, this study aims to use HFACS to extract human factors for the six recent helicopter accidents in Korea, analyze the extracted human factors in conjunction with the Dirty Dozen concept, and then present measures to prevent accidents by item

Keywords: *Safety, Aviation, Aviation accident, Human factors, Human error, Dirty Dozen, HFACS*

1. Introduction

As the aviation industry broke out over about 100 years, numerous aircraft accidents have also occurred. When an aircraft accident occurs, human and material damage and its ripple effect are significant, so it is a target to avoid with the best effort while being alert to the fact that it always coexists with us.

There are a number of factors in the cause of an aircraft accident or sub-accident related to the operation of an aircraft. Among these factors, the “Human Factor” is at the core.

The Ministry of Land, Transport and Maritime Affairs defines safety as a state in which the risk that may cause personal or property damage is maintained below an acceptable level through continuous discovery of hazards and risk management.[1]

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FAA, EASA, IATA, and Boeing, which are major organizations that conduct research and analysis for aviation safety worldwide, report that about 70% of aviation accidents are caused by human factors, and accordingly, accidents caused by human factors worldwide The degree of interest in preventive activities is increasing rapidly.[2] As part of this intent, the FAA of the United States has been raising awareness among aviation workers by publicizing 12 human errors (Boeing, 2016), which account for the largest part of aviation accidents, under the theme of Dirty Dozen to prevent aviation accidents.

Therefore, in this study, based on the domestic helicopter accidents reported to the Aviation and Railway Accident Investigation Board from 2007 to the latest, human factors were extracted using HFACS for 6 relatively recent domestic helicopter accidents, and based on the extracted human factors. As a result, after analysis in connection with the Dirty Dozen concept, a plan for preventing accidents for each derived item will be presented.

2. Theoretical consideration

2.1 Definition of HFACS

HFACS is an abbreviation of human factor analysis and classification system and was developed by US Navy behavioral scientists Wiegmann and Shappell. [3] They created a frame called HFACS and developed this system as problems with human performance increased Came.[4]

The US Navy has created a scientifically effective accident investigation framework to evaluate the impact of human efficiency deterioration on aircraft accidents, and the Swiss Cheese model was developed by Dr. James Reason of the University of Manchester, the master of human error research. And this was the foundation of HFACS. [5]

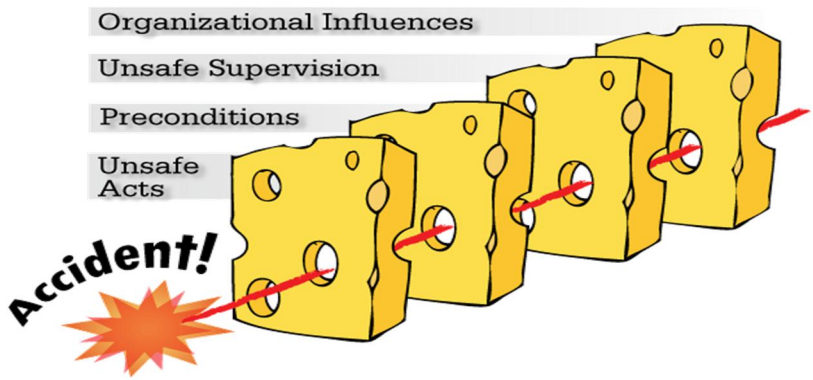

Figure 1. Swiss Cheese Model

According to the Swiss Cheese model, accidents are usually caused by a series of human errors, and it is said that there are signs related to accidents from a long time before the accident. Human errors and accidents can be prevented if the prevention system such as safety devices for accident prevention works well. However, it is explained that humans are not perfect, so there are defects, or holes in the cheese, and if a series of events unfold through these holes, it leads to accidents through final human errors.[4]

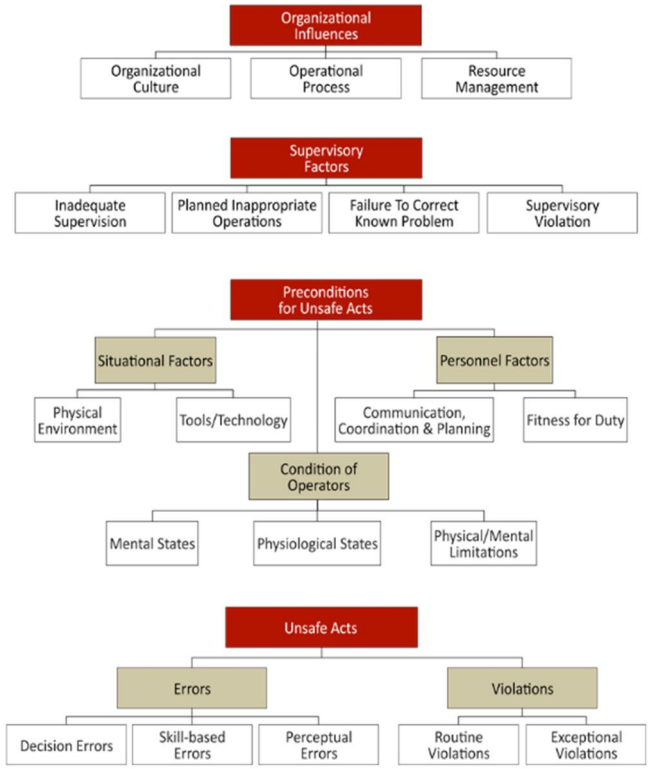

Figure 2. HFACS(Human Factors Analysis and Classification System) Model

The Swiss cheese theory, a traditional theory of human error, is a theory that accidents occur due to the accidental overlapping of the defects of multiple units. It was classified into four stages of impact [6]. However, there is a limit to the analysis of specific causes because a detailed classification list of each element is not presented. HFACS, which is mainly used for accident analysis in the aviation field, presents a list of 19 human factors subdivided into each stage in order to supplement the limitations of this Swiss cheese theory, enabling a staged and detailed analysis of human errors. [7]

2.2 Definition of Dirty Dozen

In the late 1980s and early 1990s, as the majority of maintenance-related aviation and quasi-accidents concentrated, Transport Canada identified 12 human factors that could cause maintenance errors that hinder efficient and safe operation. This is called Dirty Dozen, and the 12 factors suggested by Dirty Dozen are tools that can be usefully utilized in discussing human error in the aviation industry.[8]

Not only in Canada but also in the United States' FAA (Federal Aviation Administration), under the theme of Dirty Dozen, in order to reduce aviation accidents, 12 human errors among the factors of aviation accidents have been publicly discussed, raising awareness to aviation workers including pilots.[9]

Among the items on HFACS 19 human factors, the items corresponding to the human factors by individuals are CRM (Communication Coordination & Planning), personal preparation (Fitness for Duty), which are the prerequisites for unsafe behavior It is summarized into five categories: Decision Errors, Skill-based Errors, and Perceptual Errors, which are the errors of unsafe behavior. And the connection with Dirty Dozen for each item can be classified as shown in Fig. 3.

2.3 Analysis of the association between HFACS and Dirty Dozen

Among the HFACS items, the human factor items by individuals are CRM (Communication Coordination & Planning), Personality (Fitness for Duty), Decision Errors, Skill-based Errors, and Perceptual Errors. It is summarized into 5 categories, and the connection with Dirty Dozen for each item can be classified as shown in Fig. 3.

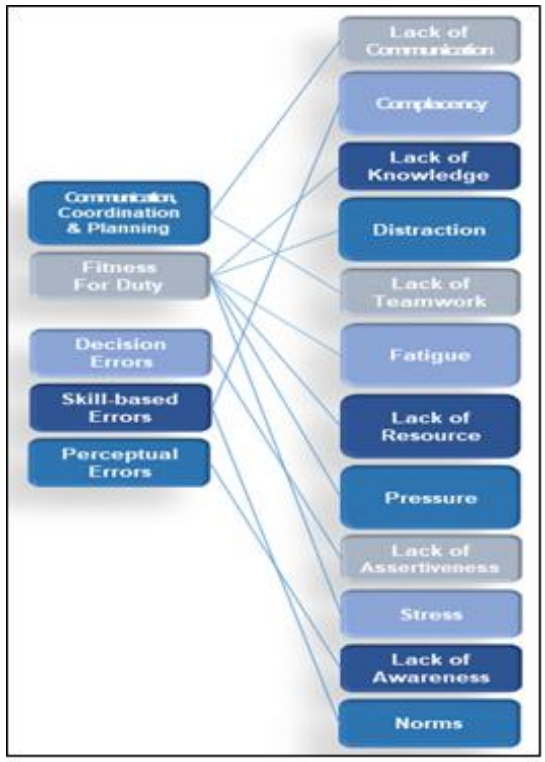

Figure 3. Correlation of HFACS & Dirty Dozen Model

3. Analysis of Civil Helicopter Accident in South Korea

3.1 Forest Aviation Headquarters rotorcraft aircraft crashed during forest fire prevention flight

(1) On May 5, 2011, at around 10:43, the Forest Aviation Headquarters Gangneung Forest Aviation Management Office AS350B-2/HL9182 helicopter, which was flying by VFR, crashed during a flight to a forest fire prevention ridge at Odaesan Mountain 6, Yeongok-myeon, Gangneung-si, Gangwon-do.

Captain HL9182 failed to maintain speed while flying too close to the cloud at the accident site, and failed to maintain the flight posture in the process of descending altitude to escape the cloud.[10]

· *Skill-based Errors → Complacency*

· *Perceptual Errors → Lack of Awareness*

(2) Captain HL9182 was unable to perform the proper escape procedure after entering the cloud at the accident site.

· *Perceptual Errors→ Lack of Awareness*

(3) In Forest Service's education and training program, the flight procedure subject was not selected as a

regular education subject in the event of a severe injury, and it was a degree to draw attention of the pilot through subject presentations during safety activities by each aviation management office.

· *Fitness for Duty→ Lack of Knowledge*

3.2 Overshock landing during emergency landing due to engine shutdown of Airpalace Co., Ltd. rotorcraft aircraft

(1) On February 9, 2013, around 11:29, the B206L-3/HL9190 rotorcraft belonging to Air Palace Co., Ltd. finished aerial photography and returned to Gimpo International Airport. Landed.
Cause and analysis of accidents
Air Palace did not separate, clean and inspect the Inline Filter and Check Valve during 12 months of inspection. As a result, the ejector pump was blocked by external contaminants, and the fuel from the front tank was not transferred to the rear tank, and fuel was depleted early during flight.[11]

· *Skill-based Errors→ Norms*

(2) The captain caused an accident due to an overshock landing on the ground due to insufficient action during the auto-rotation process due to engine shutdown during flight.

· *Skill-based Errors→ Norms*

(3) The captain turned on the low-fuel warning light during flight, but when the low-fuel warning light was turned on immediately, the captain lost time to safely land by continuing to fly without performing any action procedures. The captain was well aware of the details of the emergency procedure, but the failure to quickly perform the procedure for lighting the low-fuel warning light means that the experience factors such as the possible flight time (12-18 minutes) with residual fuel in the case of low-fuel warning and the problems that occur in case of an emergency landing. It is presumed that the lack of it gave an obstacle to quick judgment.

· *Perceptual Errors → Lack of Awareness*

(4) Air Palace conducted education and training for captains less than the time set in the operating regulations, such as 6 hours and 30 minutes for flight studies during initial training for new hires and 5 hours for flight studies during regular training in 2011 and 2012.

· *Fitness for Duty → Lack of Knowledge*

3.3 Andong Imha Lake Fall accident while approaching the surface for fresh water after forest fire extinguished

(1) S-64E/HL9467 belonging to the Korea Forest Service, which was flying in a visual flight at around 09:38 on May 9, 013, crashed into the middle stream of Lake Imha while approaching the surface of Lake Imha to clean the water tank after the fire extinguished.
The captain overlooked the altitude warning sound when approaching the surface of Lake Imha, and he misunderstood the flight altitude due to a failure in distributing attention, and due to this, the time of power increase was delayed and the aircraft descent inertia could not be controlled, resulting in a fall to the surface.[12]

· *Fitness for Duty → Distraction*

· *Skill-based Errors → Norms*

(2) The captain did not operate the “auxiliary fuel pump” during take-off, and he overlooked the altitude warning sound when approaching the surface and continued to descend, so it is presumed that he has a habit of not using the “check list”.

· *Perceltual Errors → Lack of Awareness*

(3) All crew members did not wear or carry life jackets at the time of flight, and did not receive a corrective order for the flight mission report.

· *Skilled-based Errors → Norms*

(4) The co-pilot of HL9467 calls out major flight specifications such as approach altitude and descent rate until it falls to the surface, so that the captain should help the captain to recognize the current situation, but the CRM of the flight crew does not do this was insufficient.

· *Communication Coordination & Planning → Lack of Communication*

(5) In the operating regulations, the division of missions for “mission pilot (PF)” and “assisted mission pilot (PM)” was not established, and there was no information on flight preparation or CRM procedures during flight, and there was no training record.
The production company's chief pilot's Operational Bulletin No. 26 and the manufacturer's ATM emphasized the risk of the “glass sleep effect”, but there was no course on the “free sleep effect” of the aviation headquarters, and there was no educational record for this.

· *Fitness for Duty → Lack of Knowledge*

3.4 LG Electronics helicopter crash

(1) On November 16, 2013, around 08:54, LG Electronics' S76C++ (HL9294) departing from Gimpo Airport and approaching Jamsil Heliport at around 08:54 due to loss of position and heavy fog. Crashed. It was decided to be able to fly while the captain did not meet the weather limits.[13]

· *Skilled-based Error → Norms*

· *Perceptual Errors → Lack of Awareness*

(2) Insufficient CRM in the cockpit, such as the captain and the co-pilot did not negotiate a turnaround, and the co-pilot and the flight manager also checked the weather and found that operation was impossible, but communication was insufficient, such as not suggesting non-operation when the captain decides to operate.

· *CRM(Communication Coordination & Planning) → Lack of Communication*

(3) The pilots collided and crashed into an obstacle on the ground while descending even though they could not dive in altitude in a weather condition where the location was not identified and the ground was not visible.

· *Fitness for Duty → Pressure*

· *Skill-based Errors → Complacency*

3.5 Gangwon fire helicopter crash

(1) On July 17, 2014, at around 10:53, an AS365N3/HL9461 rotary wing aircraft affiliated with the Gangwon Fire Department crashed while flying straight forward with an increased instrument flight method. HL9461 pilots did instrument flight in a state that they could not perform instrument flight because they did not meet the recent instrument flight experience required time. [14]

· *Skilled-based Error → Norms*

(2) HL9461 Pilots had insufficient instrument flight experience, insufficient flight preparation, pre-flight briefing, and communication and cooperation between the captain and the co-pilot were not smooth. The command conditions of the aviation rescue commander who can give command and advice on the aviation field to the special rescue commander of the fire department headquarters were insufficient.

· *CRM(Communication Coordination & Planning) → Lack of Communication*

(3) The education and training of the aviation rescue team was divided into flight training, rescue and first aid training, and maintenance training for technology maintenance and technical capability improvement, but recently, instrument flight and night flight that required maintenance of flight experience did not meet the training hours. I did. The standard procedures and operating rules of the air rescue team did not specify the mission classification for the “mission pilot” and the “assisted mission pilot”, and there was no information on the flight preparation or in-flight CRM procedure, and there was no training record.

· *Fitness for Duty → Lack of Knowledge*

(4) The captain flew in a tense state due to insufficient instrument flight experience and training at the beginning of take-off, lack of preparation for instrument flight, poor radio reception, and concentration of action procedures at the early stage of instrument take-off. However, these factors may have influenced the failure of the ASE speed mode connection and the sudden change of attitude of the aircraft.

· *Fitness for Duty → Pressure*

3.6 SEJIN Air service Company Helicopter(HL9617) Crash

(1) On January 30, 2016, around 14:56, Sejin Airlines' helicopter HL9617 arrived at Moaksan Provincial Park in Gimje-si, Jeollabuk-do for forest fire monitoring and crashed into a nearby hill while approaching the landing site. Due to improper maintenance of the HL9617, the T-bolt of the tail rotor was removed during flight, and the bellcrank and pitch control sleeve were separated, which resulted in loss of directional control capability. Sejin Airways has performed improper maintenance, such as installing a gearbox that cannot be used due to loss of airworthiness to the HL9617 and not being able to check the tightening status of the T-bolt fixing screws.[15]

· *Fitness for Duty → Lack of Resource*

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used due to loss of airworthiness to the HL9617 and not being able to check the tightening status of the T-bolt fixing screws.

· *Fitness for Duty → Lack of Resource*

(3) It is presumed that the captain failed to make appropriate judgments and measures in a timely manner when a sudden mail demand occurred due to a sudden loss of directional control capability.

· *Skilled-based Error → Norms*

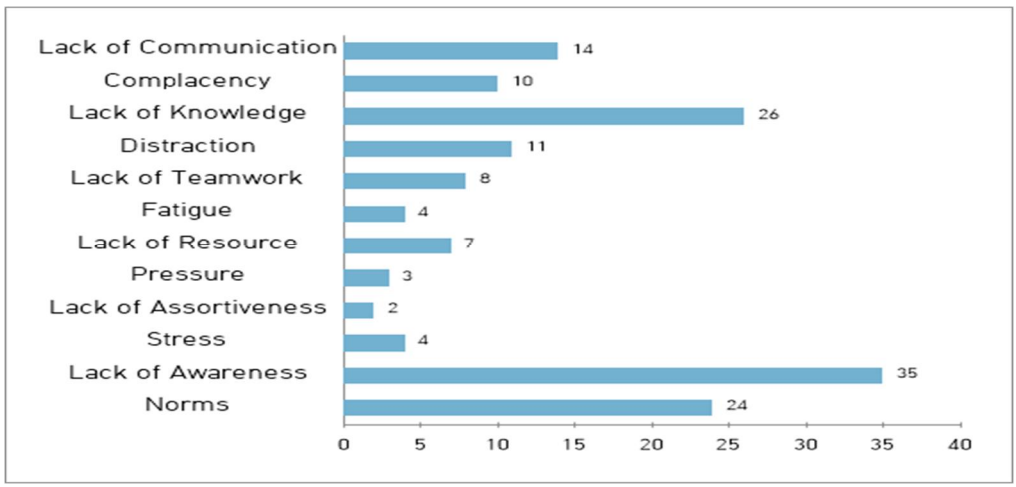

Figure 4. Distribution of Dirty Dozen in helicopter accidents by year for 11 years

As shown in Fig. 4 the three factors that account for the most frequency of the Dirty Dozen distribution are 35 cases of poor situational awareness (24%), 26 cases of lack of knowledge (18%), and 24 cases of non-compliance with procedures (16%).), accounting for about 58% with 85 out of 148 cases.

In the recent six cases of helicopter accidents in Korea, which were surveyed as a sample, the top three items, which account for the most frequency among the total Dirty Dozen items, were classified as Top. Can be seen.

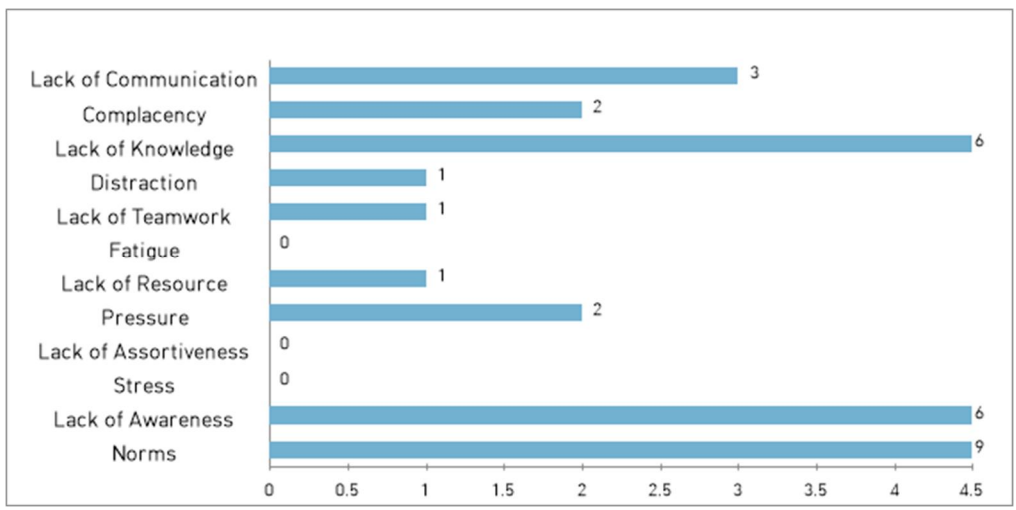

Figure 5. Distribution of the factors of Dirty Dozen in 6 cases

As shown in Fig. 5, it can be seen that this result accounts for more than half of the total 12 items, the same as 58% analyzed in the 11-year accident investigation results from 2007 to 2017.

4. Conclusion

To summarize the analysis results of this study, the results of analyzing domestic helicopter accidents and the last six domestic helicopter accidents for the past 11 years (2007~2017) using 12 triggers (Dirty Dozen),'Lack of Awareness', ' The items of'Lack of Knowledge' and'Norms' were analyzed as major causes of accidents.
As for the "Lack of Awareness," it is necessary to have an opportunity to experience directly or indirectly various situations that can occur during flight. The pilot is given a variety of situations, and education and training must be provided to perform actions optimized for the situation.
As a plan for'Norms', even though procedures such as a set checklist have already been established, most of the problems arising from overlooked by pilots account for the education and training to properly perform the prescribed procedures. This should be strengthened.
In order to solve the'Lack of Knowledge', education and training according to regulations and the role of a high-quality instructor are also very important factors to consider.
As a result of comprehensive examination, various situations are given and opportunities to experience them are required, and various education and training must be performed accurately. To solve this as a whole, we propose to introduce an education system using a simulator or VR system. For this, it is a well-known fact that the support of simulator development companies specialized for helicopters and sharing of technology must be supported, but the actual sharing of helicopter operation data and technology of major domestic companies is still insufficient. Therefore, I would like to suggest whether it would be a good way to intervene at the national level and provide support and cooperation to companies for public aviation safety.
Dirty Dozen is a very useful method for analyzing human factors, and it is expected that it will be very valuable in establishing a tool for analyzing human factors among the causes of aircraft accidents in the future.
For national aviation safety, there should be ceaseless research and race on accident prevention measures.

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