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A Study on the Impact of Human Factors for the Students Pilot's in ATO

-With Respect to Korea Aviation Act and ICAO Human Factors Training Manual-

항공법규에 의거 지정된 조종사 양성 전문교육기관의 학생조종사에 대한 휴먼팩터 영향 연구

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Contents

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Ⅰ. Introduction

Human Factors has been arisenas the significant issue for the aviation safety since enormous percentage of aviation accidents are caused by human factors.

Training on human factors is regarded seriously for the aviation personnel in Korea, therefore trainings such as Crew Resource management (CRM) and Line Oriented Flight Training (LOFT) are strengthened by airlines.

As see the curriculum related to human factors in flight training center, only designated prerequisite subjects are availableto obtain pilot license. For private pilot course, only 12 hours are assigned for human performance and limitation class out of total 180 hours of course, and for commercial pilot license, 20 hours out of 510 hours are assigned. Pilot training centers only offer less than 10% of total course duration for human performance and limitation class.

This is far insufficient from the ICAO's recommended training hours. It is also not sufficient to prevent student pilots' mechanism of accidents or incidents from human factor with given curriculum.

With continuous growth of Korean air transport industry and demand on air travel, pilots demand has been increased rapidly. In order to meet the pilots demand, government has allowed establishing Approved Training Organization (ATO), henceUljin Flight Training Center is established in July 2010 where can cultivate 200 pilots annually. This is one of the government efforts to meet the increasing demand on civil aviation pilots that generally replaced by foreign pilots or Koreans who trained overseas training center. With this effort, domestic training flights traffic is expected to be continually increased.

Safety degree on training flight by ATO is regarded as high. However, more than 80% of accidents in air transportation arecaused by human factors, and mostly by pilots' mistakes. Therefore it is very important that student pilots have in depth knowledge in safety and ability on risk management.

This study is consisted of the survey based on SHELL model which to prevent human error. The survey subject is student pilots therefore risk factors that can affect on training flight by student pilots can be identified. The survey object is to eliminate risk factors during training flights, prevent accidents or incidents and furthermore safety management for training flights can be created to maintain high safety level.

Ⅱ. Literature Review on Human Factors

Peterson(1988) made causal models that classified the reasons and causes of the unsafe behavior specifically to reduce unsafe behavior of manager by providing practical items.[1] This causal model can explain the causal connection between multiple elements until an accident occurs and configured the process ofthe primary cause factor of the human error that lead to work overload, decision error, and traps. 'Overload', the component of this model, is the inconsistency of the ability to work. Mental ability, low cognitive ability and unconsciousness are the supplementary causes of 'Decision making error'. 'Trap' can be occurred by the supplementary causes that are workplace design and incompatibility of instrument and control devices.

Cooper(1998) claimed that there are mutual relationship between the organization's safety management system, perception and attitudes about safety, and daily goal-oriented behavior.[2] Reciprocal safety culture model is verified by the organization experiences that have numerous different components relationships.

James Reason(1990) explained how human being attributes to the cause of accidents or involves in accidents of complex and interconnected aviation industry.[3]

1) Peterson(1988).
2) Cooper(1998).
3) James Reason(1990).

He emphasized that only one error of negligence or unsafe behavior in the complex system does not lead to accidents. Accidents are caused when the each element are occurred organically or there is potential risk existed in the current system.

James Reason hypothesizes that accidents caused by one or more of four level of failures which are organizational influences, unsafe supervision, preconditions for unsafe acts, and unsafe acts themselves. The defenses against these failures are modeled and when all individual barriers weaknesses align, it leads to accidents or incidents.

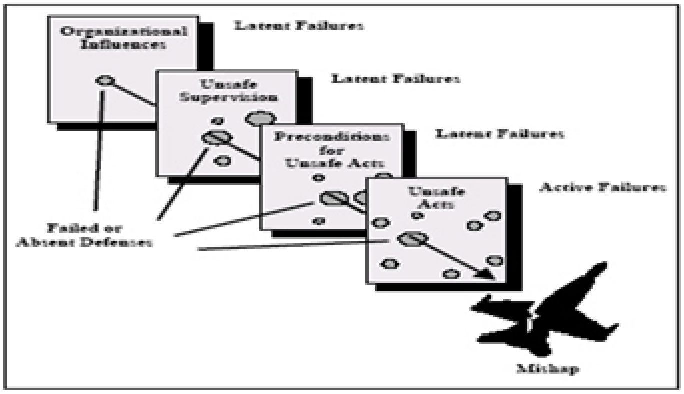

Figure 1. Swiss Cheese Model

Reason(1990), Weigmann & Shappell(1997) introduced Human Factors Analysis and Classification System(HFACS) which is analyzed from the Navy and Marine Corps' flight accidents.[4] HFACS is a comprehensive human error framework developed from Swiss cheese model and it identifies the human causation of accidents, and provides tools to aid the investigation process.

4) Weigmann & Shappell(1997).

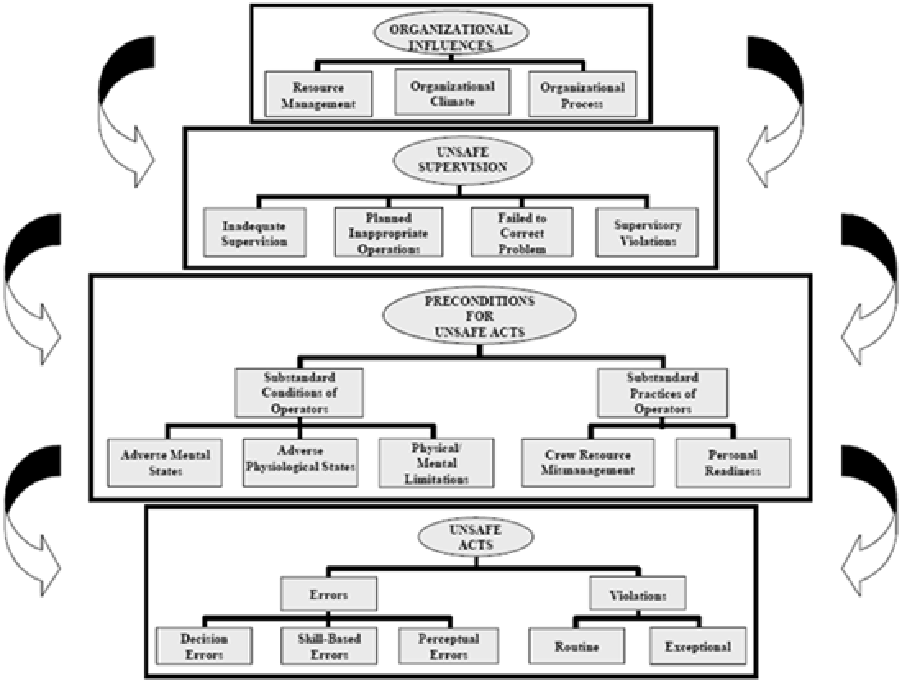

Figure 2. HFACS Model

O'Hare, Wiggins, Batt, & Morrison(1994) claims that human is the major causeof civil and military aviation accidents among human-machine interface, environment, and communication.5)

ICAO addressed in Investigation of Human Factors in accidents and incidents document, adopting investigation approach to human factors in aviation accidents and incidents has not been effective even though knowing that 'human makes errors'. Therefore, investigation authority and investigators have difficulties in investigating human factors contribution in accidents.

The most basic approach to investigating human factors in accidents and incidents is Reason's Accident causation model. ICAO recommended aviation accidents investigator on human factors must have in-depth knowledge in aviation and various

5) O'Hare, Wiggins, Batt, & Morrison(1994).

elements that could affect on flight duty.

Weigmann & Shappell(2001) claims that if current aviation accidents rate is not going to decreased further, as expected next 10 years aviation traffic is going to grow, there will be a major accident occurred every week.

Human error has been implicated in almost 70-80% of civil and military aviation accidents (Taneja, 2002). He proposed holistic approach to minimize aircraft accidents and aims to provide a composite and macroscopic view of the activities within the aviation environment that can be targeted to produce the desired results. He also emphasizes that the influence of safety culture in integrating the diverse components of the accidents prevention program is important (Taneja, 2002).

Ⅲ. Theoretical Background of the study

1. Study on Human Factors

(1) Definition of Human Factors

Human Factors can be defined as discipline of study that deals with any factors that can affect on human behaviorphysically and psychologically. Human Factor is not only focused on pilot performance but also can be applied to any aviation personnel such as air traffic controller, maintenance personnel and dispatcher.

Human Factors is also known as ergonomics. Murrell(1965) used ‘Ergonomics’, and ergonomics was generalized due to his book title. He defined ergonomics as ‘the scientific study of the relationship between man and his working environment’. Murrell(1965)

Human Factors, in a broad sense, deals with user and the system the user is in such as human-machine interface, human-human interface, human-procedures, and human-environments. ‘Human Factors’ is widely used in US and ‘Ergonomics’ is generally used in EU area.

(2) Introduction of Human Factors in Aviation

After World War, human factors studies were initiated in the need of improvement of productivity of nations and industries through hiringappropriate employees who can conduct duties efficiently at the same time providing systematic training.

In UK, Ergonomics Research Society (ERS) in 1949 and International Ergonomics Association (IEA) in 1959, in 1957 Human Factor Society (HFS) in US are established to study systemically on the ergonomic including human factors and those studies began to be applied to each industry sector.

In aviation sector, through investigation results of major and minor accidents and incidents, human factors were key factor for flight safety hence some countries developed human factors course for aviation personnel in various forms.

NASA and FAA collected extensive human error data through Aviation Safety Reporting System (ASRS) to investigate human factors as of research project, and through Confidential Human Factors Reporting Programme (CHRIP) in UK, Confidential Aviation Safety Reporting Program (CASRP) in Canada, and Confidential Aviation Incident Report(CAIR) in Australia,then research on human factors were executed.

In March 1977, due to breakdown of coordination between cockpit crew and air traffic controller KLM B-747 and Pan Am B-747 collided on the runway at Los Rodoes airport Tenerife, out of 637 passengers 583 people were dead.

United airline aircraft to Portland, Oregon was crashed due to breakdown in cockpit management and teamwork, 10 passengers were dead and 28 passengers were seriously injured in December 1978.

According to the various aircraft accidents causations including these two major accidents, accidents were caused by lack of coordination between cockpit crew and air traffic controllers. The importance of close corporation and coordination between associated personnelduring flights were aware, thereforevarious international organizations including ICAO and regional organizations such as NASA, FAA started studying on human factors for effectiveness and safety of crew work during flights.

(3) Theory of SHELL model

Various industries including aviation sector have realized the need of understating in human factors and utilization and application of the understanding in order to protect human and properties and enhance productivities through maximizing efficiency in workplace.

With the context, Elwyn Edward developed SHEL (Software, Hardware, Environment, Liveware) model which visualize the interrelationships among the crew and the aircraft system components systemically.

Elwyn Edward argues that human factors theory is more problem solving-oriented rather than theory-oriented. In addition, he argues that it is essential that human performance and the limitations have to be perceived together with resolving the discrepancy of human and surrounding environments.

Frank H. Hawakins, a former captain of KLM, modified Elwyn Edwards' SHEL model into 'building block' structure as can be seen below figure 4. The SHELL model adopts a system perspective that suggests the human is rarely the sole cause of an accident.

Each component of the SHELL model consist of Software, Hardware, Environment, and Liveware represent a building block of human factors. The human element which is the most critical component is at the center of the SHELL model that represents the modern air transport system.

In the centre of the model "L" represents Liveware which means humans in the workplace,for instance cockpit crew, air traffic controller, management and administration personnel and maintenance personnel. The other system component must be carefully adapted and matched to this central component to accommodate human limitation.

"L" on the bottom of the model stands for those persons at the front line of operation who conduct duties.

"H" is Hardware which is any physical element of the aviation system such as aircraft, operator equipment, tools, computers and buildings.

"S" is Software that represents non physical and intangible aspects of the aviation system that govern howthe aviation system operates including rules, instructions, regulations, laws, checklist, operating procedure, symbology, computer program and procedural checklists.

"E" represents Environment that internal air transport environment includes the physical factors like cabin temperature, air pressure, humidity, noise, ambient light levels and physical environment outside the work area such as weather, terrain, and physical facilities.

The below 'L' means human who interacts with central human operator who involves in duty directly.

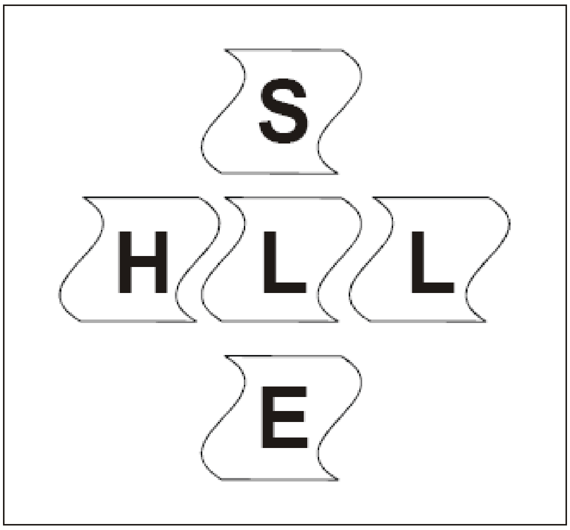

Figure 3. SHELL Model

The SHELL model indicates relationships between people and other system components and therefore provides a framework for optimizing the relationship between people and their activities within the aviation system. As any component that surrounds Liveware can directly affect on aircraft operations, those components interaction and interface should bekept in optimum level in order to keep efficiency and ensure safety.

(4) Criteria of Human Factors Training

Training on human factors are to change aviation personnel's attitude and behavior, hence training should be conducted for long term systemically and periodically rather than short term. Thus such positive attitude and behavior changes can be habituated through constant management and supervision.

ICAO encourages human factors training by setting standards of human factors education in order to aviation personnel to aware human factors such as human performance and the limitation and foster basic human factors knowledge.

However, standardized program development for technical training on human factors is not enabled since implementation methods and program contents can be differed by different circumstances. Hence regional seminars on human factors are held periodically to realize rational procedures of the program.

Description of ICAO's recommended Human factors training for aviation personnel can be found below table.

Table 1. Human Factors Curriculum

Subject	Curriculum	Percentage (%)	Hours (Hour + Minute)
1	Introduction of Human Factors	5	1 + 45
2	Physiology	20	7 + 00
3	Psychology	30	10 + 30
4	Fitness for Duty	5	1 + 45
5	Liveware-Hardware	5	1 + 45
6	Liveware-Software	10	3 + 30

7	Liveware-Liveware	15	5 + 15
8	Liveware-Environment	10	3 + 30
Total	8 Subjects	100	35 + 00

Source: ICAO, Doc 9683 - Human Factors Training Manual, 2005

2. Theoretical review on training flight

(1) Definition of Training Flight

Training Flight can be defined as an instruction received from a flight school to accumulate flight experiences to obtain flight certificate.

According to the Aviation Act Article 35, trainingflight is explained as practice flight performed by a person holding certification of flightand that of medical examination for aircrew on board aircraft (limited to aircraft of limited category) other than that of a limited class or type, under the supervision of a person holdingcertification of qualification and that of medical examination for aircrew by which he/she is allowed to pilot the aircraft including those who are designated by the Minister of Land, Transport and Maritime Affairs. Practice flights have to be performed under the supervision of a person holding the flight instruction certification after obtaining permission from the Minister of Land, Transport and Maritime Affairs. When any person who has received written permission for practice flights, he or she has to carry such written permission and certificate of medical examination for crew.

In case of U.S, FAA does not permit practice flight but issue student pilot certificate for solo flight.

(2) Flight training center status

Flight training center is to conduct training flight, and it is also called as ATO (Authorized Training Organization). Government designates the ATO to train pilots. Excluding Air force, Army and Navy, there are total three ATOs which are Flight training center by Korea aerospace University, Hanseo University Flight training center, and Uljin Flight Training Center.

Flight training center is categorized by training centre under airlines totrain own staff, and specialized educational institutions that designated by Ministry of Land, Transport and Maritime Affairs under Aviation Act Article 29-3 and Ministerial Regulation of Aviation Act Article 93.

There are no specific requirements to establish airlines' flight training centre in Korea but, the government approval is required for education regulations, training subjects and methods(including training program), training equipments and tools, and status of inspectors.

Designated ATO is required to set education plan containing education subjects and education methods, training discipline in purpose of training qualified pilot and carry out designated duties effectively. In case of completing applicable course, part of qualification examination can be exempted. Korea aerospace university, Hanseo University, Airforce, Army and Navy are designated to operate part of courses.

Designated ATO can be categorized to military training institutions and civil training institution as can be seen in table 2. This study surveyed students who trained in civil training institutions so that a description of military training institutions was excluded. There are Korea Aerospace University and Hanseo University for civil training institution, and Uljin flight training centre that co-opened by Korea Aerospace University and Hanseo University. The status of flight training centre is shown in the below table.

Table 2. Current condition of Korea's Approved Training Organization

	Course	Training Period	Available Trainee number(Annually)
Korea Aerospace University (12 Aircraft)	Private pilot	3 Months	150
	Commercial pilot	9 Months	90
	Instrument flight certificate	3 Months	30
	Certified flight instructor	3 Months	30
Hanseo University	Private pilot	6 Months	20
	Commercial pilot	12 Months	40

(12 Aircraft)	Certified flight instructor	3 Months	20
Airforce (160 Aircraft)	Commercial pilot	17 Months(82 Weeks)	120
	Commercial pilot(Ⅰ)	72 Weeks	50
	Commercial pilot (Ⅱ)	3.5 Months(15 Weeks)	50
	Certified flight instructor	1 Week	90
Army (65 Aircraft)	Commercial pilot	27 Weeks	80
	Commercial pilot	13 Weeks	50
	Instrument flight certificate	8 Weeks	30
Navy (59 Aircraft)	Private pilot	22 Weeks	30
	Commercial pilot	-104 Weeks(Fixed) -160 Weeks(Rotational)	30
	Instrument flight certificate	10 Weeks	50
	Certified flight instructor	8 Weeks	25
	Private/Commercial	14 Weeks	25
Total	-	-	1,100 Annually

Source : Ministry of Land, Transport and Maritime Affairs, The office of Aviation, 2010

Ⅳ. Study Design

1. Study Model

The study model is created based on SHELL model by Frank H. Hawkins(1975).6) SHELL model is generally used to understand human factors, and it enables to understand interaction between human, software, equipment, and environmental factors.

A mismatch of the interface of people and other system components such as Liveware-Software(L-S), Liveware-Hardware(L-H), Liveware-Environment(L-E), Liveware-Liveware(L-L) and Liveware(L) can be a major source of human error. In the study, it is presumed that human factors based on SHELL model will affect on safety of training flights, and also hypothesized that human factors will be varied

6) Frank H. Hawkins(1975).

by flight experiences and characteristics of organization. The model in the study is designed based on those assumptions.

2. Sample Composition

The study is about human factors that affect on training flight safety, hence the subjects were 3rd and 4thyear university student pilots from flying course and helicopter flying course, and general public pilots. Total 121 surveys were distributed between 10th of October and 20th of October 2010, and 1 faulty responded survey was eliminated. Total 120 surveys were analyzed and the sample composition can be found below table.

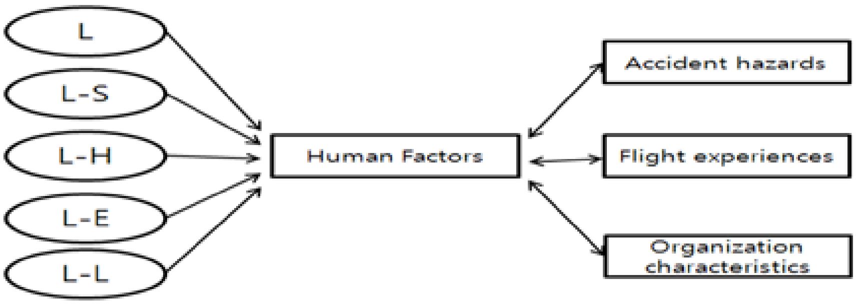

Figure 4. Study Model

Table 3. Demographic Characteristics

Division		Frequency	Percentage
Total		120	100%
Gender	Male	118	98.3%
	Female	2	1.7%
Affiliation	Flying course	61	50.8%
	Flying Helicopter course	21	17.5%
	General Trainee	38	31.7%
Grade	3rd Year	41	34.2%
	4th Year	41	34.2%
	General Trainee	38	31.7%
Flying training	Private pilot course	93	77.5%

course	Instrument flight course	4	3.3%
	Commercial pilot course	23	19.2%
Flying Hours	1~50 Hours	61	50.8%
	51~100 Hours	31	25.8%
	Over 101 Hours	28	23.3%

3. Hypothesisof the study

In the study, it is tried to verify that how variables such as accidents hazard, flight experiencesand organization culture could affect on human factor. Human factor variables are, also, set based on SHELL model facotrs and the Liveware, pilot's Liveware, placed in the middle of SHELL model. The interactions between Liveware and other variables which are Software, Hardware, and Environment are established as detailed human factors.

In the study, thus, below hypothesis are set to be verified that how three variables such as accident hazards, flight experiences, and organization characteristics have an effect on interaction between Liveware and other system components.

Hypothesis 1

Hypothesis 1-1 Accident hazards and Liveware are interrelated.

Hypothesis 1-2 Accident hazards and Liveware-Software are interrelated.

Hypothesis 1-3 Accident hazards and Liveware-Hardward are interrelated.

Hypothesis 1-4 Accident hazards and Liveware-Enviroment areinterrelated.

Hypothesis 1-5 Accident hazards and Liveware-Liveware are interrelated.

Hypothesis 2

Hypothesis 2-1 As flight experience is lesser, value of Liveware that affects on safety will be greater.

Hypothesis 2-2 As flight experience is lesser, value of Liveware-Software that affects on safety will be greater.

Hypothesis 2-3 As flight experience is lesser, value of Liverware-Hardware that affects on safety will be greater.

Hypothesis 2-4 As flight experience is lesser, value of Liveware-Environment that affects on safety will be greater.

Hypothesis 2-5 As flight experience is lesser, value of Liveware-Liveware that affects on safety will be greater.

Hypothesis 3

Hypothesis 3-1 Value of Liveware that affects on safety will be differed by pilot organization characteristics.

Hypothesis 3-2 Value of Liveware-Software that affects on safety will be differedby pilot organization characteristics.

Hypothesis 3-3 Value of Liveware-Hardware that affects on safety will be differed by pilot organization characteristics.

Hypothesis 3-4 Value of Liveware-Environment that affects on safety will be differed by pilot organization characteristics

Hypothesis 3-5 Value of Liveware-Liveware that affects on safety will be differed by pilot organization characteristics,

V . Empirical Analysis

1. Reliability Analysis

First of all, reliability analysis was conducted for each survey item under SHELL model's human factors variables.

Liveware, Liveware-Software, Liveware-Hardware, Liveware-Liveware factors' reliability analysisresults were all used without elimination since those α value is greater than 0.6 which is standard reliability value.

Result of reliability analysis for Liveware-Environment is 0.586 αvalue which is less than 0.6 reliability standard value. To increase overall reliability of Liveware – Environment factor, item 18 was removed which regarded as the least reliable item as when this item is removed Cronbach's α value is 0.605. Therefore, when item 18 is eliminated, Livewere-Enviroment factor can be used as reliable measuring factor.

Table 4. Reliability Analysis

Factor	Measuring Item	Eliminated Item Cronbach's α	Cronbach's α
Liveware	1	.725	.714
	2	.631	
	3	.683	
	4	.687	
	5	.631	
	6	.718	
	7	.677	
Liveware-Software	8	.481	.601
	9	.545	
	10	.686	
	11	.463	
	12	.545	
Liveware-Hardware	13	.708	.774
	14	.690	
	15	.759	
	16	.745	
	17	.756	
Liveware-Environment	18	.605	.586
	19	.485	
	20	.549	
	21	.498	
	22	.491	
Liveware-Liveware	23	.766	.714
	24	.718	
	25	.592	
	26	.619	
	27	.599	

2. Factor Analysis

Factor analysis was conducted to those factors which passed reliability verification. Number of factor was determined when eigen value is greater than 1, and common factor was set with standard factor loading 0.5. Principal component analysis is used as extraction model, and varimax rotation among orthogonal rotation is used to analyze.

Result of factor analysis of Liveware variables is listed below table 5, and 2 factors are derived out. Factor 1 is 'Pilots' internal factor' and factor 2 is 'Pilot's capability'.

Table 5.Result of factor analysis of Liveware

Question Number	Factor 1	Factor 2
3	.869	-.145
2	.772	.279
7	.580	.298
1	.521	.030
4	.134	.788
6	-.084	.767
5	.468	.690
Eigen value	2.702	1.376
Variance Ratio	38.6%	19.7%
Cumulative Ratio	38.6%	58.3%

The second human factor is the interaction of Liveware-Software. The result of factor analysis on variables can be found in table 6, and two factors are derived which are "Adequacy of Flight log book"as factor 1 and "Skipping Checklist" as factor 2.

Table 6. Result of factor analysis of Liveware-Sofeware

Question Number	Factor 1	Factor 2
8	.787	.073
12	.743	-.110
9	.668	.081
11	.650	.400
10	.018	.963
Eigen value	2.133	1.019
Variance Ratio	42.7%	20.4%
Cumulative Ratio	42.7%	63.1%

The interaction of Liveware-Hardware variable's factoranalysis result can be found in table 7. One factor is derived and it is called "Equipments in cockpit".

Table 7. Result of factor analysis of Liveware-Hardware

Question Number	Factor 1
14	.831
13	.794
17	.686
16	.675
15	.657
Eigen value	2.679
Variance Ratio	53.6%
Cumulative Ratio	53.6%

From the 4th human factor, Liveware-Environment variable, two factors are derived through reliability analysis. The analysis result is listed in table 8 and factor 1 is "Organizational culture" and factor 2 is "Weather/obstacle".

Table 8. Result of factor analysis of Liveware-Environment

Question Number	Factor 1	Factor 2
21	.864	.061
22	.795	.187
20	.039	.872
19	.219	.791
Eigen value	1.836	1.018
Variance Ratio	45.9%	25.4%
Cumulative Ratio	45.9%	71.3%

From the factor analysis of the interaction of Liveware-Liveware, two factors are derived and the results are given in table 9.

Factor 1 is "Human relationship outside aircraft", Factor 2 is "Human relationship inside aircraft".

Table 9. Result of factor analysis of Liveware-Liveware

Question Number	Factor 1	Factor 2
26	.904	.011
27	.882	.117
25	.847	.188
23	-.023	.836
24	.230	.756
eigenvalue	2.517	1.168
Variance Ratio	50.3%	23.4%
Cumulative Ratio	50.3%	73.7%

Those values of factors derived from the factor analysis are converted to draw new values that used for analysis for hypothesis verification.

3. Hypothesis Verification and Analysis

(1) Hypothesis 1 Verification

Table 10. Hypothesis 1 verification summary

Hypothesis	Measuring Factor	Coefficient correlation	Reference
1-1. Accident hazards and Liveware are interrelated.	Pilot's internal Factor	.494**	Adopt Hypothesis
	Pilot's capability	.513**	
1-2. Accident hazards and Liveware-Software are interrelated.	Flight log data Adequacy	.227*	Reject Hypothesis
	Skipping checklist	.223*	
1-3. Accident hazard and Liveware-Hardward are interrelated.	Equipments in cockpit	.487**	Adopt Hypothesis
1-4. Accident hazard and Liveware-Enviroment are interrelated.	Organization culture	.271**	Adopt some
	Weather/ Terrain	.422**	

1-5. Accident hazard and Liveware-Liveware are interrelated.	Human relationship inside aircraft	.037	Reject Hypothesis
	Human relationship outside aircraft	-.257**	

**. Coefficient correlation's level of significance is 0.01
*. Coefficient correlation's level of significance is 0.05

The most correlated factors among human factors are Liveware, especially 'pilot's capability', followed by Liveware-Hardware from the analysis of Hypothesis 1 verification. That can be explained as student pilots' flight capability, knowledge in academic and regulation are critical for training flight safety. 'Equipment in cockpit' is concluded as associated with accident hazard; this is mainly regarded as students use different aircraft each time. Hence adaptability and judgment to operate equipmentswill be significantly related to safety of flight.

Lastly, "Weather/obstacle" factor has 0.422 of correlations with accidents hazard because mostly weather and obstacles can be obstacle to pilot in case of visual flights. This matter is considered as actually involving in training flight safety.

(2) Hypothesis 2 verification

Table 11. Hypothesis 1 verification summary

Hypothesis	Measuring Factor	p-value	Average tendency	Reference
2-1. As flight experience is lesser, value of Liveware that affects on safety will be greater.	Pilot's internal Factor	0.044	Getting smaller	Adopt some
	Pilot's capability	0.005	Getting bigger	
2-2. As flight experience is lesser, value of Liveware-Software that affects on safety will be greater.	Flight log data Adequacy	0.000	Getting bigger	Adopt some
	Skipping checklist	0.175	Getting smaller	
2-3. As flight experience is lesser, value of Liverware-Hardware that affects on safety will be greater.	Equipments in cockpit	0.039	Getting bigger	Adopt Hypothesis
2-4. As flight experience is lesser, value of Liveware-Environment that affects on safety will be greater.	Organization culture	0.179	No tendency	Reject Hypothesis
	Weather/ Terrain	0.963	No tendency	

2-5. As flight experience is lesser, value of Liveware-Liveware that affects on safety will be greater.	Human relationship outside aircraft	0.367	No tendency	Reject Hypothesis
	Human relationship inside aircraft	0.016	No tendency	

Level of significance is P<0.05

The hypothesis analysis result shows the significant differences in "Pilot's internal factor" and "Pilot capability". However, according to average tendency, 'Pilot's capability' is affected greater when 'Pilot's capability' is lesser as lesser flight experience. However, as "Pilot's internal factor" is larger, it is affected greater. This can be explained as experienced student pilots have difficulties during flights due to lack of management for own condition.

As pilots have lower level of flight experiences, it is analyzed that they have difficulties in using flight information and handling equipments appropriately. The "Human relationship outside the aircraft" of Liveware-Liveware factor shows significant differences, however looking at the average, there is no tendency as level of flight experience is getting lower, consequently hypothesis is rejected.

(3) Hypothesis 3 verification

Table 12. Hypothesis 1 verification summary

Hypothesis	Measuring Factor	p-value	Reference
3-1. Value of Liveware that affects on safety will be differed by pilot organization characteristics.	Pilot's internal Factor	0.022	Adopt some
	Pilot's capability	0.536	
3-2. Value of Liveware-Software that affects on safety will be differed by pilot organization characteristics.	Flight log data Adequacy	0.700	Reject Hypothesis
	Skipping Checklist	0.880	
3-3. Value of Liveware-Hardware that affects on safety will be differed by pilot organization characteristics,.	Equipments in cockpit	0.016	Adopt Hypothesis
3-4. Value of Liveware-Environment that affects on safety will be differed by pilot organization characteristics,.	Organization culture	0.009	Adopt some
	Weather/ Terrain	0.429	

3-5. Value of Liveware-Liveware that affects on safety will be differed by pilot organization characteristics,	Human relationship inside aircraft	0.036	Adopt some
	Human relationship outside aircraft	0.564	

Level of significance is P<0.05

Hypothesis 3 is analyzed to compare the difference of human factors depending on the characteristics of the student pilots. OnlyLiveware-Software factor was rejected and others have been adopted or partly adopted.

"The pilot's internal factor" among Liveware factor derived significant statistical analysis that group of student consists of student pilots have internally impacted greatly. This is caused by student pilots are mentally burdened as their flying is evaluated each time and reflected to the grades.

It is analyzed that "Cockpit equipments" influences enormously to general public student pilots. It can be explained as the general public student pilots fly unsteadily consequentlythey rarely use cockpit equipments compare to other students pilots who are familiar with cockpit equipments and operation principles. Therefore there are differences between the two groups of student pilots.

"Organization culture" of Liveware-Environment factors shows a statistically significant difference. It is compared according to the characteristic of pilot groups, the differences can be seen in the 'Organization culture'. Organization culture of the current students was shown to be more affecting on the flight since the relationshipbetween senior and junior, power distance between instructors and students, and military organization involve in the formation of the organization culture and even affectthe actual flights.

It is also analyzed that there was significant difference in "Human relationship inside aircraft" factor. Humans inside the aircraft are instructors and students, and the actual flight performance can be varied a lot depends on the students and instructors as students affected by the instructor and the relationship thus this matter can affect training flight safety.

Ⅵ. Conclusion

Human factors in aviation have been studied extensively however human factors on student pilot have not been studied previously. As can be seen previous studies, there are very strong relationships between accidenthazard and human factors. Especially relationship on Liveware and Liveware-Hardware isstrongly related to the flight safety. Organization Culture affects strongly on human, even though there is not direct effect on accident hazard however, it can be regard as potential risk factors on accident.

In order to improve overall safety in aviation, aviation industry seriously take human factors as priority for safety, therefore airlines in Korea continually strive to prevent any accidents or incidents from human factors through human factor training such as CRM and LOFT.

However, the human factors training in flight training center is far not sufficient to effectively educate students, and student pilots do not recognize human factorsas potential risk factors that lead to accidents in flights. Hence flight training center must recognize this issue and must improve and develop furtherhuman factors training and education.

To study on human factors affect on flight safety, it is critical to analyze the degree of human factors influences on actual accidents. The limitation of this study exists due to lack of training flight accidents statistics hence accident hazard variables are derived from only sample subjects'accidents experiences. Therefore critical factors that can lead to actual accidents could not derive to meaningful analysis.

In particular, even though skipping checklist can lead to accidents directly, checklist skipping was not significant in accident hazard analysis in this study.

Therefore, it is strongly recommended to supplement this limitation through constantly collect data on aviation incidents and aviation safety barriers that can create accurate accident analysis.

The most critical factor in flight training is interaction between students and instructor. The interaction with instructor significantly influences on students performance. However, in-depth examination on interaction between students and instructor has not been conducted in this study therefore it needs to be examined thoroughly in the future for training flight safety improvement.

Human factors that can lead to accidents have significant potential risk that has not been revealed yet. Due to that aspect, detailed human factors study has limitation. It is clear that the risk related to human factors is greater than those values from this analysis results because accidents cannot be predicted.

In spite of this limitation, human factors study on training flight is conducted in the study with the intention of improving training flight safety and increasing safety awareness of student pilots.

It is obvious that further research is required to analyze human factors deals with not only student pilots but also flight instructors and other related personnel. Therefore deepen research can help to enhance overall safety of training flights with meeting the increased training flights demand.

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Abstract

A Study on the Impact of Human Factors for the Students Pilot's in ATO
-With Respect to Korea Aviation Act and ICAO Human Factors Training Manual-"

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Statistics of aviation accident in Korea show that safety level of training flights is high. However, more than 80% of aviation accidents happen owing to human factors. And because most reasons of them are concerned with pilot error, it is very important for student pilots who will transport a lot of passengers to develop the knowledge of safety and abilities of risk management for preventing accidents.

In this study, in order to investigate the Human Factors which affect safety in training student pilots for flight, verified the correlationbetween experiences of accident, the differences according to the experience level of training flight and the differences between college student pilots and ordinary student pilots on the basis of human factors that composes the SHELL models. For the study, Using SPSS 17.0, conducted Correlation Analysis, Analysis of Variance(ANOVA) and t-test.

To sum up the result of this study, student pilot's ability and equipment in the cockpit are the important factors for safety when pilots are training flight. Also the analysis of the differences between human factors according to the characters of student pilots' groups shows that college student pilots are affected by immanent factors and organizational cultures.

So far, there haven't been any accidents which is related with human casualties when training at the ATO(Approved Training Organization). But accidents can occur at any time and anywhere. Especially the human factors which comprises most of aviation accident have a wide reach and are impossible to be eliminated, therefore, it is best to minimize them. Because ATO is the starting point to lead the aviation industry of Korea, we will have to be aware of problems and improve education/training of human factors.

Key Words : ATO, Human Factors, SHELL model, Training Flight, Accident Risk, Co-relation

초 록

항공법규에 의거 지정된 조종사 양성 전문교육기관의 학생조종사에 대한 휴먼팩터 영향 연구

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본 연구는 국내 훈련비행을 수행하는 학생조종사를 대상으로 SHELL 모델에 근거한 인적요인(Human Factors)에 초점을 맞추어 연구가 진행되었다. 연구 가설을 검증하기 위해SHELL 모델은 바탕으로 평가요소를 만들었고, 각 인적요인별 요인분석에서 추출된 변수를 사용하여 사고위험과의 상관관계, 비행경험수준과는 분산분석, 그리고 조직 특성과는 t-test를 실시하였다.

연구 결과, 사고위험과 조종사의 개인적 요소(Liveware), 사고위험과 조종사-장비 관계(Liveware-Hardware)는 관련성이 있고, 개인적 요소(Liveware)의 변수인 조종사의 내적요인과 조종사의 기량 모두 비행경험수준이 낮을수록 인적요인에 의한 영향을 많이 받는 것으로 분석되었다. 마지막으로 학생 조종사 조직의 특성에 따라 인적요소(Human Factors)들의 차이를 비교분석한 결과, 재학생으로 구성된 학생조종사의 그룹이 내적으로 영향을 많이 받고 있고, 조종석내 장비 부분에서는 일반인 학생 조종사가 받는 영향이 큰 것으로 나타났다.

항공분야의 인적요인(Human Factors)에 관한 연구는 활발히 진행 중이나 학생조종사를 대상으로 한 인적요인에 관한 연구는 이루어지지 않았다. 기존의 선행연구와 같이 본 연구에서도 사고 위험과 인적요인과의 관계는 밀접한 관련이 있으며, 특히 개인적 요소(Liveware)와 조종사-장비(Liveware-Hardware) 관계가 안전성에 많은 관련이 있음을 보였다. 또한 인적요인 중 조직문화라는 요인도 인간에게 많은 영향을 주고 있고, 실제 사고위험에 직접적인 영향은 없으나, 잠재적인 위험성이 큰 요인이라 판단된다.

전 세계적으로 항공사고의 안전성을 향상시키기 위해 인적요인(Human Factors)을 주요 문제로 삼고 있고, 국내 항공사에서도 인적요인 훈련으로서 승무원 상호협

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조(CRM)와 노선적응훈련(LOFT) 훈련을 정기적으로 하고 있는 등 인적요인의 중요성을 인지하고 이로 인한 사고를 방지하기 위해 지속적으로 노력하고 있다. 그러나 훈련비행을 실시하고 있는 비행훈련기관에서는 인적요인에 관한 훈련은 부족하며, 학생들이 인적요인(Human Factors)에 관한 이론으로 인식할 뿐이지 실제 훈련비행상에서 사고로 이어질 수 있다는 잠재적 위험성을 인지하지 못하고 있다. 우리나라 항공 산업을 이끌고 갈 조종사를 양성하는 교육기관으로써, 이러한 문제를 인식하고 인적요인 교육·훈련을 개선해 나가야 할 것이며 이러한 점은국내 항공법이나 항공법규에 의거 지정된 전문교육기관의 교과과정개선에 반영되어야 할 것이다.

주제어 : 조종사양성전문교육기관, 인적요인, SHELL모델, 비행훈련, 사고위험, 상관관계