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Comparative study on hazardous attitudes and safe operational behavior in airline pilots

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ABSTRACT

The purpose of this study is to analyze the differences in hazardous attitudes and safe operation behavior according to cultural differences and flight experience. In particular, the study tries to analyze these differences between Korean and non-Korean airline pilots and according to total flight experience. A survey was conducted on airline pilots that work at Korean Air, and a total of 147 collected surveys were analyzed using a *t*-test and ANOVA. The analyses showed differences between Korean and non-Korean airline pilots as well as according to total flight experience.

1. Introduction

Safety is the most important issue in the aviation industry, and as such, airlines are engaging in various efforts to enhance the safety of their overall operations. Recently, among issues related safety, there has been a growing interest in the hazardous attitudes and safe operation behavior of pilots. Airlines are now making a significant effort to evaluate and understand these two factors with respect to their pilots (Ji et al., 2011). Depending on how a pilot recognizes and estimates a hazard during flight, the pilot may show hazardous attitudes, which would affect safe operation behavior. The extent of these attitudes and behavior might differ depending on the personal characteristics of pilots, including their cultural background and flight experience (Hunter, 2005).

Korean Air, Korea's representative national airline, hires many of its pilots from abroad, thus creating a multicultural environment. For this reason, it is important to understand how cultural differences affect hazardous attitudes and safe operation behavior with respect to aircraft operation. Such studies on cultural differences have been conducted mainly in the domain of general management (Liao, 2015). However, there have been almost no studies on how the cultural background of airline pilots affects hazardous attitudes and safe operation behavior. Also, according to Wetmore and Lu (2005), hazardous attitudes and safe operation behavior may change depending on flight experience. As of yet, no studies have been conducted on airlines in Korea regarding the difference in hazardous attitudes and safe operation behavior depending on flight experience. Therefore, this study aims to rectify this gap in the literature. In particular, this study tries to analyze the differences in hazardous attitudes and safe operation behavior between Korean and non-Korean pilots as well as the differences in hazardous attitudes and safe operation behavior depending on total flight experience.

2. Literature review

The term hazardous attitudes refers to the tendencies of individuals to react to stimuli in such a way that risks increase in a given situation or event. It is also important to note that hazardous attitudes can be changed through training (Ji et al., 2011). In other words, hazardous attitudes can be defined as a personal motivation tendency that affects an individual's ability to make good decisions and apply good judgment while piloting an aircraft (FAA, 1999). At present, this research area is receiving significant attention in the aviation field. In particular, research on hazardous attitudes and safe operational behavior is on the rise in the aviation field. The hazardous attitudes concept is a basic element that is included in

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most of the professional education program curriculums for pilots (FAA, 1999). In order to reduce hazardous attitudes, one should recognize danger and apply the appropriate behavior. Hazardous attitudes can mitigate the good judgment of a pilot, so these attitudes affect flight safety (FAA, 1991). Wiener and Nagel (1988) asserted that hazardous attitudes were one of the most important human factors influencing aeronautical decision-making processes. Hazardous attitudes can be changed and modified through training, and it was found that individual forms of hazardous attitudes were related to aeronautical decision-making (ADM), crew resource management (CRM), and self-reported accidents (Buch and Diehl, 1984; Wetmore and Lu, 2006). Ji et al. (2011) reported that it was possible to change hazardous attitudes and risk awareness in airline pilots with respect to safe operational behavior and flight safety. In the present study, a survey questionnaire on hazardous attitudes was created by referring to the relevant research. The questionnaire was designed to examine hazardous attitudes by investigating three particular elements that could subsequently be applied to an exploratory factor analysis with the collected data. These elements were (a) anxiety and worry about accidents during flight, (b) conceit regarding one's ability to handle any flight-related situation, and (c) spontaneity when responding to events, making impulsive or momentary decisions without fully considering the situation.

Safe operational behavior, which is similar to concepts such as communication, collaboration, decision-making, workload management, situational awareness, and flight automation management, is related to non-technical skills or social psychological skills performed or displayed by airline pilots during flight duties. Also, these skills help airline pilots to guarantee flight safety (O'Connor et al., 2002; You et al., 2009). Previous research on safe operational behavior has primarily looked at differences according to personal characteristics and social awareness variables. For example, previous studies have attempted to examine how risk tolerance and the 'big five' personality variables – honesty, integrity, extroversion, jollity, and neurosis– have affected safe operational behavior (Berg et al., 2002; Pauley et al., 2008; Poropat, 2009). Also, a continuous stream of research has been carried out on the effects of safe operational behavior by examining social awareness variables such as attitudes regarding flight safety, perceived risks, and social regulations (O'Hare, 1990; Hunter, 2005; Stewart and John, 2006; Ji et al., 2011). The present study created a survey questionnaire on safe operation behavior based on previous studies. This survey listed four factors that comprised hazardous attitudes with the intent that an exploratory factor analysis could be conducted on the collected data. The four factors were (a) leadership and management via the application of non-technical or socio-psychological competence in order to guarantee safe operation during flight, (b) communication and cooperation, (c) situation awareness and decision-making, and (d) understanding and predicting automation.

3. Methodology

This study aimed to analyze the differences between airline pilots in terms of hazardous attitudes and safe operational behavior in flight. To check for differences in the levels of pilot awareness for each factor, the population was divided by nationality (Korean and non-Korean) and total flight experience. The research hypotheses are shown in Table 1. On the basis of the three hazardous attitude factors and four safe operation behavior factors, the hypotheses were designed to analyze differences based on nationality and total flight experience.

Ji et al. (2011) used 24 questions to assess hazardous attitudes. These questions targeted six factors – self-confidence, impulsive, worry/anxiety, macho, antiauthority, and resignation. Also, 27 questions were used to measure safe operation behavior. They targeted four factors – automation system understanding, leadership and management, situation awareness and decision-making, and communication and cooperation. The present study drew up its survey questions based on the factors and list of measurements used in the Ji et al. (2011) study. Some of factors that Ji et al. (2011) used to measure hazardous attitudes and safe operation behavior contained elements that were not applicable to a study of commercial airline pilots. Accordingly, in order to modify existing survey questions and create new questions that were more appropriate, in-depth interviews were conducted with Korean Air flight crews. The authors then attempted to compose survey questions that would help elicit a better understanding of the hazardous attitudes and safe operation behavior of airline pilots. In order to determine that the pilots would be able to understand the questions, and in order to test the validity of the questions, a pilot study was conducted for Korean and non-Korean crew members working for Korean Air. Pilots were asked to answer the questions and point to particular questions that needed to be modified. Through the in-depth interviews and pilot study, the final questions were determined. Ultimately, the final survey was composed of a total of 56 questions, including 18 questions measuring hazardous attitudes, 27 questions measuring safe operational behavior, and 11 questions designed to provide demographic divisions. A five-point Likert scale was used to facilitate data collection. The measurement questions for hazardous attitudes and safe operational behavior are shown in Tables 2 and 3.

To conduct an empirical analysis, the surveys were distributed to Korean and non-Korean airline pilots working at Korean Air. The survey was conducted for 24 days from May 24, 2013 to June 16, 2013. The surveys were filled out in two locations, Korean Air Headquarters at Gimpo International Airport and in Incheon International Airport's Pilot Briefing Room. A total of 150 copies were distributed to Korean pilots and 50 copies were distributed to non-Korean pilots. From the 200 distributed surveys, 165 copies were collected. In the process of filling out the survey there were almost no questions from the responders regarding question clarity, so it was determined that they had a good understanding of the questions. Excluding 18 surveys (11%) that could not be used due to incomplete responses to all questions, 147 surveys (89%) were used for the analysis. The general characteristics of the samples are represented in Table 4. The sample size of the flight crew used for the analysis in this study was relatively small. According to the central limit theorem in statistics, 30 is the usual minimum sample size (Cohen et al., 2013). As the sample size grows, the average distribution approaches a normal distribution. Statistical estimation is possible via the average and distribution, so a sample size of 30 or more is sufficient. Therefore, the sample size in this study was deemed adequate.

4. Empirical results

4.1. Reliability and validity verification

To verify the validity of the research in this study, first an exploratory factor analysis was conducted. All measurement variables were run through a principle component analysis (PCA) to derive the configuration factors. To simplify the factor load value, the orthogonal rotation method (Varimax) was used. In the results of the exploratory factor analysis for hazardous attitudes, excluding eight items among the 18 that did not meet the standard, the 10 questions were bound into three factor types – spontaneity factors (four questions), anxiety factors (three questions), and conceit factors (three questions). The Kaise-Meyer-Olkin (KMO) value of

Table 1
Hypotheses regarding hazardous attitudes and safe operational behavior during flight.

H1: The anxiety hazardous attitude factor will show differences between Korean and non-Korean airline pilots.
H2: The conceit hazardous attitude factor will show differences between Korean and non-Korean airline pilots.
H3: The spontaneity hazardous attitude factor will show differences between Korean and non-Korean airline pilots.
H4: The anxiety hazardous attitude factor will show differences according to total flight hours.
H5: The conceit hazardous attitude factor will show differences according to total flight hours.
H6: The spontaneity hazardous attitude factor will show differences according to total flight hours.
H7: The leadership and management safe operational behavior factor will show differences between Korean and non-Korean airline pilots.
H8: The communication and collaboration safe operational behavior factor will show differences between Korean and non-Korean airline pilots.
H9: The situation awareness and decision-making safe operational behavior factor will show differences between Korean and non-Korean airline pilots.
H10: The understanding and predicting automation safe operational behavior factor will show differences between Korean and non-Korean airline pilots.
H11: The leadership and management safe operational behavior factor will show differences according to total flight hours.
H12: The communication and collaboration safe operational behavior factor will show differences according to total flight hours.
H13: The situation awareness and decision-making safe operational behavior factor will show differences according to total flight hours.
H14: The understanding and predicting automation safe operational behavior factor will show differences according to total flight hours.

Table 2
Measurement items for hazardous attitudes.

Factor	Question	Survey question
Anxiety	A1	In an uncontrolled area with lots of traffic, I worry about the possibility of a mid-air collision.
	A2	I always worry about an accident when I'm flying.
	A3	If I fly over water, I worry about having to ditch if the engine quits.
	A4	In a tight situation, I believe in doing anything rather that doing nothing.
Conceit	A5	I am a pilot due entirely to my hard work and ability.
	A6	I like to see how close I can cut things.
	A7	If I have done something illegal while flying, I will report it myself because I figure someone will report it anyway.
	A8	I can learn any flying skill if I put my mind to it.
	A9	If I had an accident, it would be the result of bad luck.
	A10	If gusty cross-winds were keeping other pilots on the ground, I'd consider flying anyhow to see if I could do it.
	A11	I feel like yelling at people who do not clear the runway fast enough when I'm on final approach.
Spontaneity	A12	In flying, what will be, will be.
	A13	If the weather is marginal, I do not mind waiting at the airport until it clears up.
	A14	I really hate being delayed when I fly on a trip.
	A15	If I want to fly somewhere, I want to do it now.
	A16	I might dip into my fuel reserve to avoid a fuel stop and save time.
	A17	In a tight situation, I trust to fate.
	A18	When it's windy out, I like to work on my cross-wind landings.

the three factor types was found to be 0.665, which is normal, so it was determined that the variable selection for the factor analysis was appropriate. In addition, Bartlett's sphericity was calculated at 305.763, and the significance probability was 0.000. Thus, it was shown that the factor analysis model was suitable (Table 5).

In the results of the exploratory factor analysis of safe operational behavior, it was found that excluding one question among the 27 questions that did not meet the standard, 26 questions could be bound into four components – automation/prediction (seven questions), situational awareness/decision (eight questions), leadership/management (six questions), and communication/cooperation (five questions). The KMO value of the four variables of safe operational behavior was quite good at 0.917. There were no problems with respect to variable selection. Bartlett's sphericity was 2062.31, and the significance probability was 0.000. Thus, the factor analysis model was deemed suitable (Table 6).

The results of the reliability analysis of the hazardous attitudes and safe operational behavior measurements found reliability in all cases. The hazardous attitude anxiety factor showed a Cronbach's α value of 0.741 in three questions. (One question was excluded from the initial questions.) Four questions were removed from the conceit factor, resulting in a value of 0.602 for the three remaining questions. Three factors were removed from the spontaneity factor, resulting in a value of 0.684 for the four remaining questions. Among the four safe operational behavior factors, three of them showed high Cronbach's α values. Automation/prediction was measured at 0.868, situational awareness/decision at 0.879, and leadership/management at 0.823. For the communication/collaboration factor, one of the five questions was removed, resulting in a value of 0.823. Thus, reliability was deemed sufficient in the selected variable questions (Table 7). Based on the factor and reliability analyses, results from a total of 10 measurement questions were used in the final analysis for hazardous attitudes. In the final analysis for safe operational behavior a total of 26 measurement questions were used.

4.2. Hypothesis verification

4.2.1. Hazardous attitudes differences between Korean and non-Korean pilots

To analyze the differences between Korean and non-Korean pilots regarding hazardous attitudes, a *t*-test was used (Table 8). In the difference analysis for the factors bound through the exploratory factor analysis results, the spontaneity and conceit factors showed statistically significant differences ($p < 0.001$). The spontaneity factor for the Korean pilots' average value was higher than that of the non-Korean pilots. This suggests that the Korean pilots had a more spontaneous attitude and that the non-Korean pilots judged situations more reasonably. The average value for the conceit factor was higher for the non-Korean pilots, indicating that the non-Korean pilots revealed more attitude traits related to conceit. For the anxiety factor, it was found that the differences between the Korean and non-Korean pilots were not statistically significant.

In the results of the *t*-test for a total of 10 questions, statistically

Table 3
Measurement items for safe operational behavior.

Factors	Question	Survey question
Leadership/ Management	S1	Cabin crew is included as part of team in briefings, as appropriate, and guidelines are established for coordination between flight deck and cabin. Passengers are briefed and updated as needed concerning delays, weather, etc.
	S2	Tasks and workload are clearly distributed and sufficient time is provided, and these tasks and workload are accepted by other crews.
	S3	Crew members can identify and report on their own or others work overload situation.
	S4	Operational tasks are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties, such as dealing with passenger needs, crew meals, and company communications.
	S5	Operational plans and decisions are clearly stated to other crew members and acknowledged, and include cabin crew and others when appropriate.
	S6	Briefings are operationally thorough, interesting, and address crew coordination and planning for potential problems, such as rejected T/Os, engine failure after lift off and go-around at destination.
Communication/ Cooperation	S7	An environment for open communications is established and/or maintained. Crew members listen with patience and make eye contact as appropriate.
	S8	There is appropriate and good group climate. Crew members do not interrupt or talk over, and they do not rush through the briefing.
	S9	When dealing with new staff, lines, airports, and other conditions, the crew members can take the initiative to share operational knowledge and experience.
	S10	Crew members speak up and state their information with appropriate persistence until there is some clear resolution and decision.
	S11	The captain shows leadership and coordinates flight deck activities. He/she strikes a balance between authority and crew member participation, yet acts decisively when necessary.
	S12	Crew members can note the appearance of fatigue and take effective means to demonstrate high levels of vigilance, such as conversation, activities, caffeine, moving, and so on.
Situational Awareness/ Decision	S13	Crew Members exchange information regarding FMC capabilities, limitations, and operations.
	S14	Crew members demonstrate high levels of vigilance in both high and low workload conditions.
	S15	The crew prepares for expected or contingency situations, including approaches, weather, etc.
	S16	Crew members state critical information and/or solutions with appropriate persistence.
	S17	Objectively, without disguise to accept the work of the feedback.
	S18	When disputes occur, crew members can still focus on current problems or situations and actively listen to the suggestions and comments. They can correct their mistakes, thereby enabling the disputed issues to reach consensus and resolution.
	S19	Crew members ask questions regarding crew actions and decisions, e.g. effective inquiries about the uncertainty of clearance limits, or clarification of confusing or unclear ATC instructions.
	S20	Given to conduct a positive or negative feedback at appropriate times, as a direct learning experience to whole crew, such as the comments on the takeoff or landing.
Automation/Prediction	S21	The captain can deliver an effective briefing, and he/she can foresee biases that occur during normal operations.
	S22	Automated systems are used at appropriate levels. When programming demands might reduce situational awareness and create work overloads, the level of automation is reduced or disengaged, or automation is effectively used to reduce the workload.
	S23	Guidelines are followed for the operation of automated systems. When systems are disabled, PF and PM [PNF] duties.
	S24	Crew members verbalize and acknowledge entries and changes to automated system parameters.
	S25	Aircraft automation systems are reviewed and confirmed regularly. This includes, for example, the best sailing condition and correct runway profiles.
	S26	When the plane goes into automation status and system parameters are modified, the crew members notice each other in a timely manner.
	S27	PF and PM [PNF] duties are established and implemented. For example, input dates and interaction are checked.

significant differences were found for eight questions. These differences regarding hazardous attitudes can be summarized as follows (Table 9). First, among the eight questions, the average values were higher for the non-Korean pilots in three of the questions. Non-Korean pilots showed greater levels of concern regarding air collisions in non-controlled areas where there was a lot of traffic. In addition, they assumed that they had been offered employment only because of their efforts and capacity. Accordingly, they felt that if an accident were to happen, bad luck would be to blame. Collectively then, non-Korean flight crew personnel displayed higher levels of conceit than domestic pilots.

Second, among the eight questions in which statistically significant differences were found, the average values for the Korean pilots were higher in five questions. It was found that Korean pilots had higher levels of concern regarding ditching when flying over water. They were willing to use reserve fuel to avoid flight interruptions and to save time. Also, Korean pilots disliked delays in flight to a greater extent than non-Korean pilots, and they also showed a stronger preference for flying right away whenever possible. It was accordingly concluded that Korean pilots had more spontaneity compared to non-Korean pilots. Additionally, Korean pilots showed that they were willing to fly to test their ability even when other pilots were grounded due to cross-winds.

4.2.2. *Difference comparison for hazardous attitudes according to total flight experience*

In the results of the one-way ANOVA analysis of hazardous attitude differences according to total flight experience, it was found that there were no differences with respect to the spontaneity and anxiety factors, but there was a statistically significant difference in the conceit factor ($p < 0.001$). The detailed results are shown in Table 10.

After determining a statistically significant difference for the conceit factor, a post hoc analysis showed a difference between the ‘over 10 thousand hours’ and ‘1–5 thousand hours’ groups (see Table 11). The former group showed a higher average value in conceit compared to the latter group. This difference could be attributed to flight experience and confidence; the ‘over 10 thousand hours’ group consisted mostly of captains while the ‘1–5 thousand hours’ group consisted primarily of first officers.

4.2.3. *Safe operational behavior difference comparison between Korean and non-Korean pilots*

In the *t*-test of the four factors of safe operational behavior, differences were found between Korean and non-Korean pilots for all factors. In each case, the average values for the non-Korean pilots were found to be higher, suggesting that non-Korean pilots generally paid greater attention to safe operational behavior than Korean pilots (Table 12).

Table 4
Sample characteristics.

Division		Number of responders	Ratio (%)
Gender	Male	146	99.3
	Female	1	0.7
Age	~40	41	27.9
	41–50	66	44.9
	51–60	32	21.8
	61~	8	5.4
Nationality	Korean	118	80.3
	non-Korean	29	19.7
Total flying hours	~1 thousand hours	11	7.5
	1–5 thousand hours	51	34.7
	5–10 thousand hours	47	32.0
	10 thousand hours~	38	25.9
Flying hours in current model	~5 hundred hours	22	15.0
	5 hundred~1 thousand hours	28	19.0
	1–5 thousand hours	51	34.7
	5 thousand hours~	46	31.3
Current aircraft model	B744	51	34.7
	B777	44	29.9
	A380	6	4.1
	A330	13	8.8
	B737	33	22.4
Working years	~5	51	34.7
	5–10	30	20.4
	10–15	29	19.7
	15~	37	25.2
Title	Captain	71	48.3
	First officer	76	51.7
Position	Screening flight crew	6	4.1
	Flight crew trainers	6	4.1
	Administrative crew	9	6.1
	Line Crew	126	85.7
Flight background	Military	79	53.7
	Civilian	68	46.3
Number of total responders		147	100

Table 5
Exploratory factor analysis result of hazardous attitudes.

Configuration concepts	Measurement items	Factor loading values	Commonality	Unique value	Cumulative variance
Spontaneity	A15	0.777	0.619	2.202	22.016
	A3	0.771	0.595		
	A16	0.673	0.518		
	A14	0.609	0.416		
Anxiety	A10	0.838	0.779	2.051	42.525
	A11	0.812	0.660		
	A9	0.763	0.656		
Conceit	A5	0.788	0.622	1.769	60.217
	A1	0.751	0.598		
	A4	0.664	0.560		
Kaise-Meyer-Olkin (KMO)		0.665			
Bartlett's sphericity		305.763			
Significance probability		0.000			

Next, in the results of the *t*-test of the 26 questions on safe operational behavior, which was carried out in order to check for differences between responders by question, differences were found between Korean and non-Korean pilots in 21 questions. For 14 of these questions, the significance levels were under 1%, showing very clear differences ($p < 0.001$). The response averages for all questions with differences were higher for non-Korean pilots. In other words, non-Korean pilots were paying more attention to safe operational behavior compared to Korean pilots. Among the 14 questions where the average values of the non-Korean pilots were higher, there were questions related to collaboration between pilots and cabin crew (S1, S6), the workload of the crew (S2, S3), manpower allocation and priorities for the efficient processing of flight operations (S4), the leadership of the captain as well as the decision-making process and delivery (S5, S7, S11, S21), group atmosphere and the identification and determination of problems (S8, S10, S19), and automation systems (S22, S26) (Table 13).

4.2.4. Differences comparison for safe operational behavior according to total flight experience

In the factor-specific one-way ANOVA analysis of the differences in safe operational behavior according to total flight experience, three out of the four factors – situational awareness/decision, leadership/management, and communication/collaboration – showed statistically significant differences (Table 14). The difference according to total flight experience in the automation/prediction factor showed a significance probability of 0.217, meaning that there was no statistical difference. In the post hoc analysis for the situational awareness/decision factor, there were differences between the ‘over 10 thousand hours’ and ‘1–5 thousand hours’

Table 6
Exploratory factor analysis result of safe operational behavior.

Configuration concepts	Measurement items	Factor loading values	Commonality	Unique value	Cumulative variance
Automation/prediction	S13	0.489	0.541	4.458	17.148
	S14	0.700	0.535		
	S15	0.653	0.513		
	S16	0.708	0.652		
	S18	0.650	0.552		
	S19	0.665	0.711		
	S20	0.726	0.617		
Situational awareness/decision	S17	0.604	0.584	4.249	33.490
	S21	0.629	0.641		
	S22	0.577	0.650		
	S23	0.706	0.662		
	S24	0.698	0.545		
	S25	0.602	0.590		
	S26	0.604	0.499		
	S27	0.533	0.467		
Leadership/management	S10	0.748	0.682	3.631	47.454
	S11	0.798	0.701		
	S12	0.587	0.635		
	S4	0.553	0.618		
	S6	0.537	0.463		
	S8	0.653	0.537		
Communication/cooperation	S1	0.626	0.687	3.209	59.797
	S2	0.662	0.672		
	S3	0.757	0.670		
	S5	0.609	0.554		
	S7	0.467	0.570		
Kaise-Meyer-Olkin (KMO)		0.917			
Bartlett's sphericity		2062.310			
Significance probability		0.000			

Table 7
Reliability of the measured variables.

Variable	Configuration concepts	Initial number of questions	Removed items	Final number of questions	Cronbach's α value
Hazardous attitudes	Anxiety	4	1	3	0.741
	Conceit	7	4	3	0.602
	Spontaneity	7	3	4	0.684
Safe operational behavior	Automation/prediction	7	–	7	0.868
	Situational awareness/decision	8	–	8	0.879
	Leadership/management	6	–	6	0.823
	Communication/collaboration	6	1	5	0.828

Table 8
Hazardous attitude differences comparison between Korean and non-Korean pilots (Via factor and *t*-test).

Question	Nationality	Average	Levene's test for equality of variances		*t*-test for equality of the average	
			F	Significance probability	t	Significance probability (both sides)
Spontaneity	Korean	2.9174	0.000	0.984	9.915	0.000***
	non-Korean	1.7155				
Anxiety	Korean	3.0508	1.224	0.270	0.028	0.978
	non-Korean	3.0460				
Conceit	Korean	3.4915	3.437	0.066	−5.105	0.000***
	non-Korean	4.2184				

Note: *p < 0.05, ***p < 0.001.

groups. The former group had a higher average value of safe operational behavior. In the post hoc analysis for the leadership/management factor, it was found that there were differences between the 'under 1 thousand hours' and the '1–5 thousand hours' groups, and there were also differences between the 'over 10 thousand hours' and '1–5 thousand hours' groups. Pilots from the 'under 1 thousand hours' and 'over 10 thousand hours' groups had higher average values of safe operational behavior. Finally, in the post hoc analysis for the communication/collaboration factor, it was confirmed that there were differences between the 'over 10 thousand hours' and '1–5 thousand hours' groups. Pilots in the former group had higher average values of safe operational behavior (Table 15).

5. Conclusions and discussions

This study analyzed the characteristics of airline pilots, specifically searching for differences in hazardous attitudes and safe operational behavior. In particular, Korean and non-Korean pilots were investigated with an emphasis on cultural differences. Analyses were also carried out for differences according to total flight experience. The results of the study can be summarized as follows.

Table 9
Hazardous attitude difference comparison between Korean and non-Korean pilots (Via questions and *t*-test).

Question	Nationality	Average	Levene's test for equality of variances		*t*-test for equality of the average	
			F	Significance probability	t	Significance probability
A1	Korean	3.0593	10.036	0.002	−6.020	0.000***
	non-Korean	4.1379				
A3	Korean	3.3898	0.835	0.362	9.467	0.000***
	non-Korean	1.5517				
A4	Korean	3.7712	0.015	0.903	−1.766	0.080
	non-Korean	4.1034				
A5	Korean	3.6441	0.562	0.455	−4.301	0.000***
	non-Korean	4.4138				
A9	Korean	3.6864	0.060	0.808	−2.425	0.017*
	non-Korean	4.1724				
A10	Korean	3.1525	5.916	0.016	2.582	0.014*
	non-Korean	2.4483				
A11	Korean	2.3136	4.633	0.033	−0.867	0.392
	non-Korean	2.5172				
A14	Korean	3.2034	6.930	0.009	2.705	0.010*
	non-Korean	2.5517				
A15	Korean	2.6356	9.168	0.003	7.355	0.000***
	non-Korean	1.4138				
A16	Korean	2.4407	2.613	0.108	6.801	0.000***
	non-Korean	1.3448				

Note: *$p < 0.05$, ***$p < 0.001$.

Table 10
One-way ANOVA analysis result according to flying hours.

Factor	Sum of squares	df	Mean square	F	Sig
Spontaneity	1.446	3	0.482	0.843	0.473
Anxiety	2.978	3	0.993	1.433	0.236
Conceit	8.413	3	2.804	5.544	0.001*

Note: *$p < 0.05$.

First, there were differences between awareness levels among Korean and non-Korean pilots regarding hazardous attitudes. There were differences in the spontaneity and conceit factors. For the spontaneity factor, the response average value of the Korean pilots was higher, and for the conceit factor, the response average value of the non-Korean pilots was higher. Also, in the differences analysis for the questions, differences were found in eight of the 10 questions. In three questions, non-Korean pilots showed higher average values, and in five questions, Korean pilots showed higher average values. Second, there were differences in the awareness of pilots regarding hazardous attitudes according to total flight time. Differences were found between the 'over 10 thousand hours' and

Table 11
Conceit variable post hoc analysis results by flight time.

Variable	Group(I)	Group (J)	Mean difference (I-J)	Std. error	Sig
Conceit	-1 thousand hours	1–5 thousand hours	0.17944	0.22721	0.959
		5–10 thousand hours	−0.12121	0.23298	0.995
		10 thousand hours -	−0.43700	0.24079	0.391
	1–5 thousand hours	-1 thousand hours	−0.17944	0.22721	0.959
		5–10 thousand hours	−0.30065	0.14127	0.195
		10 thousand hours -	−0.61644	0.15381	0.001*
	5–10 thousand hours	-1 thousand hours	0.12121	0.23298	0.995
		1–5 thousand hours	0.30065	0.14127	0.195
		10 thousand hours -	−0.31579	0.16221	0.284
	10 thousand hours-	-1 thousand hours	0.43700	0.24079	0.391
		1–5 thousand hours	0.61644	0.15381	0.001*
		5–10 thousand hours	0.31579	0.16221	0.284

Note: *$p < 0.05$, ***$p < 0.001$.

Table 12
Safe operation behavior difference comparison between Korean and non-Korean pilots (Via factors and *t*-test).

Question	Nationality	Average	Levene's test for equality of variances		*t*-test for equality of average	
			F	Significance probability	t	Significance probability
Automation/prediction	Korean	4.2554	1.391	0.240	−2.954	0.004*
	non-Korean	4.5222				
Situational awareness/decision	Korean	4.1525	0.030	0.862	−3.916	0.000***
	non-Korean	4.5000				
Leadership/management	Korean	3.7034	0.419	0.519	−8.055	0.000***
	non-Korean	4.4598				
Communication/cooperation	Korean	3.9949	0.256	0.614	−8.684	0.000***
	non-Korean	4.6897				

Note: *$p < 0.05$, ***$p < 0.001$.

Table 13
Safe operation behavior difference comparison between Korean and non-Korean pilots (Via questions and *t*-test).

Question	Nationality	Average	Levene's test for equality of variances		*t*-test for equality of average	
			F	Significance probability	t	Significance probability
S1	Korean	3.7966	0.088	0.767	−6.685	0.000***
	non-Korean	4.6552				
S2	Korean	3.8644	1.238	0.268	−6.173	0.000***
	non-Korean	4.6207				
S3	Korean	4.0593	2.334	0.129	−5.880	0.000***
	non-Korean	4.6897				
S4	Korean	3.8644	0.197	0.658	−7.395	0.000***
	non-Korean	4.7241				
S5	Korean	4.0847	6.121	0.015	−4.678	0.000***
	non-Korean	4.6207				
S6	Korean	3.8136	3.358	0.069	−4.622	0.000***
	non-Korean	4.4138				
S7	Korean	4.1695	5.128	0.025	−8.519	0.000***
	non-Korean	4.8621				
S8	Korean	3.6186	0.004	0.951	−4.415	0.000***
	non-Korean	4.2414				
S10	Korean	3.3390	0.373	0.542	−5.934	0.000***
	non-Korean	4.3448				
S11	Korean	3.6525	0.645	0.423	−6.648	0.000***
	non-Korean	4.6207				
S12	Korean	3.9322	7.122	0.008	−3.091	0.004*
	non-Korean	4.4138				
S13	Korean	4.0169	12.778	0.000	−3.460	0.001*
	non-Korean	4.4138				
S14	Korean	4.2288	2.157	0.144	−1.366	0.174
	non-Korean	4.4138				
S15	Korean	4.2881	5.333	0.022	0.529	0.600
	non-Korean	4.2069				
S16	Korean	4.3475	3.078	0.081	−3.279	0.001*
	non-Korean	4.7241				
S17	Korean	4.1356	3.736	0.055	−3.103	0.002*
	non-Korean	4.5172				
S18	Korean	4.2034	1.060	0.305	−2.569	0.011*
	non-Korean	4.5172				
S19	Korean	4.3220	5.950	0.016	−4.498	0.000***
	non-Korean	4.7586				
S20	Korean	4.3814	0.141	0.708	−1.881	0.062
	non-Korean	4.6207				
S21	Korean	4.0847	0.480	0.490	−3.755	0.000***
	non-Korean	4.5862				
S22	Korean	4.3305	9.455	0.003	−4.372	0.000***
	non-Korean	4.7586				
S23	Korean	4.2966	0.000	0.986	−2.060	0.041*
	non-Korean	4.5517				
S24	Korean	4.0678	2.355	0.127	−0.815	0.416
	non-Korean	4.1724				
S25	Korean	4.0000	7.932	0.006	−3.761	0.001*
	non-Korean	4.5172				
S26	Korean	4.2373	0.643	0.424	−3.605	0.000***
	non-Korean	4.6207				
S27	Korean	4.0678	11.323	0.001	−1.326	0.193
	non-Korean	4.2759				

Note: *p < 0.05, ***p < 0.001.

Table 14
One-way ANOVA analysis result for the automation/prediction factor according to flight hours.

Variable	Sum of squares	df	Mean square	F	Sig
Automation/prediction	0.891	3	0.297	1.501	0.217
Situational awareness/decision	2.428	3	0.809	4.295	0.006*
Leadership/management	4.956	3	1.652	6.196	0.001*
Communication/cooperation	2.393	3	0.798	3.746	0.013*

Note: *p < 0.05.

'1–5 thousand hours' groups for the conceit factor; the average response value of the former group was higher. Third, in the differences in awareness of safe operational behavior, there were differences between the non-Korean and Korean pilots. In all four factors, differences were found in the safe operational behavior between the non-Korean and Korean pilots. The average value was higher in non-Korean pilots for safe operational behavior. Also, in the results of the differences analysis for the questions, differences

Table 15
Post hoc analysis results of the situational awareness/decision factor by flight time.

Variable	Group(I)	Group (J)	Mean difference (I-J)	Std. error	Sig
Situational awareness/decision	-1 thousand hours	1–5 thousand hours	0.31529	0.14432	0.132
		5–10 thousand hours	0.17094	0.14540	0.643
		10 thousand hours -	0.00478	0.14863	1.000
	1–5 thousand hours	-1 thousand hours	−0.31529	0.14432	0.132
		5–10 thousand hours	−0.14435	0.08778	0.357
		10 thousand hours -	−0.31050	0.09303	0.006*
	5–10 thousand hours	-1 thousand hours	−0.17094	0.14540	0.643
		1–5 thousand hours	0.14435	0.08778	0.357
		10 thousand hours -	−0.16615	0.09470	0.300
	10 thousand hours -	-1 thousand hours	−0.00478	0.14863	1.000
		1–5 thousand hours	0.31050	0.09303	0.006*
		5–10 thousand hours	0.16615	0.09470	0.300
Leadership/management	-1 thousand hours	1–5 thousand hours	0.51307	0.17166	0.017*
		5–10 thousand hours	0.34752	0.17295	0.189
		10 thousand hours -	0.09649	0.17679	0.948
	1–5 thousand hours	-1 thousand hours	−0.51307	0.17166	0.017*
		5–10 thousand hours	−0.16555	0.10441	0.390
		10 thousand hours -	−0.41658	0.11066	0.001*
	5–10 thousand hours	-1 thousand hours	−0.34752	0.17295	0.189
		1–5 thousand hours	0.16555	0.10441	0.390
		10 thousand hours -	−0.25103	0.11265	0.121
	10 thousand hours -	-1 thousand hours	−0.09649	0.17679	0.948
		1–5 thousand hours	0.41658	0.11066	0.001*
		5–10 thousand hours	0.25103	0.11265	0.121
Communication/cooperation	-1 thousand hours	1–5 thousand hours	0.24813	0.16764	0.610
		5–10 thousand hours	0.11721	0.18000	0.984
		10 thousand hours -	−0.07416	0.17938	0.999
	1–5 thousand hours	-1 thousand hours	−0.24813	0.16764	0.610
		5–10 thousand hours	−0.13091	0.09167	0.634
		10 thousand hours -	−0.32229	0.09044	0.004*
	5–10 thousand hours	-1 thousand hours	−0.11721	0.18000	0.984
		1–5 thousand hours	0.13091	0.09167	0.634
		10 thousand hours -	−0.19138	0.11171	0.427
	10 thousand hours -	-1 thousand hours	0.07416	0.17938	0.999
		1–5 thousand hours	0.32229	0.09044	0.004*
		5–10 thousand hours	0.19138	0.11171	0.427

Note: *$p < 0.05$.

were found in 21 of 26 questions. In those 21 questions, it was found that non-Korean pilot response average values were higher, indicating that non-Korean pilots paid more attention to safe operational behavior. Finally, there were differences in the awareness of safe operational behavior according to total flight experience. Three of the four factors – situational awareness/decision, leadership/management, and communication/collaboration – showed differences. These differences mostly occurred between the ‘over 10 thousand hours’ and ‘1–5 thousand hours’ groups, with the response average values of flight time being higher for the former group.

Based on the overall results, the following implications emerge. First, this study analyzed the hazardous attitudes and safe operation behavior of pilots – an increasingly important issue in the Korean aviation industry – depending on pilot characteristics and found that there were differences that derived from cultural background and flight experience. These results can be used as base data for studies on pilot safety attitudes. Second, this study found differences between the hazardous attitudes and safe operation behavior of Korean and non-Korean pilots. Compared to domestic pilots, non-Korean pilots were more confident about flying and had stronger wills regarding safe operation behavior. In the case of Korean pilots, their average values of safe operation behavior were low. Airline companies would do well to determine the specific reasons for this phenomenon and look for ways to improve the situation. There were differences in working patterns, the operation of breaks, selection conditions, and working conditions. These differences cause attitudes to vary, so a more detailed understanding is needed with respect to the effects of these factors on hazardous attitudes and safe operation behavior. Lastly, it was found that hazardous attitudes and safe operation behavior differ depending on the total flight experience. In particular, pilots with more flight hours had higher averages in their responses regarding safe operation behavior. This can be attributed to the differences in experience between highly experienced and less experienced pilots and differences in awareness between captains and co-pilots. Accordingly, airlines would benefit from a better understanding of the causes of the differences in hazardous attitudes and safe operation behavior depending on working experience. This would subsequently allow airlines to consistently work to establish ways to complement their system to improve the safe operation behavior of less experienced pilots and allow pilots and other individuals to actively exchange information regarding flights.

This study has limitations that can serve as the basis for future research. The factors analyzed in this study were centered on differences stemming from being a Korean or non-Korean pilot and stemming from the total number of hours flown. Although the causes of the differences were deduced from the data, it was difficult to confirm the deductions empirically. In a future study, empirical confirmation could be confirmed by using homogeneous samples for each targeted population for the purposes of comparison. The survey questions could then be reconfigured accordingly. Moreover, more detailed distinctions need to be determined with respect to face-to-face surveys, flight times, and working periods. Also, because this study was conducted on pilots employed with Korean Air, the research domain was limited. Because the subjects worked at the same airline, although they may have been from different cultural and aviation backgrounds, it is quite possible that they would have been homogenized through familiarization. To overcome and objectify these limitations, there is a need to include airline pilots working in other airlines in the scope of research.

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