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Evaluating Non-Technical Skills of Airline Pilot Candidates Using an Analytic Hierarchy Process (AHP) Approach

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Abstract

This study evaluates the non-technical skills (NOTECHS) of airline pilot candidates using the Analytical Hierarchy Process (AHP) approach. It aims to determine the importance and weighting of these skills in pilot selection processes. Nine non-technical competencies used in pilot selection within a Turkish aviation company were identified and weighted based on their importance across various flight stages (preflight, take-off, cruise, approach/landing, taxi) using the AHP technique. Scenarios based on real flight operations were evaluated by experienced flight examiners. The analysis revealed that situation awareness, problem-solving, and decision-making were the most critical non-technical skills across all phases of flight. Leadership and communication also played significant roles, while planning and professional development were less critical. As a result of the analysis, theoretical and practical suggestions in the field of aviation were presented.

1. Introduction

Commercial aviation is one of the world's largest industries, and ensuring safe operations requires professionalism and coordination among a wide range of professionals, including pilots, who are a critical human factor. Research shows that pilot error accounts for a significant portion of these accidents (IATA, 2021; Kaya & Ates, 2023; Lenné et al., 2008; Li et al., 2001; Oster et al., 2010; Wiegmann et al., 2005). Over the last 100 years, numerous studies have been conducted on pilot selection. With a growing need for pilots (Airbus, 2023; Boeing, 2023; CAE, 2023), the emphasis on selecting pilots with both technical and non-technical skills (NOTECHS) has increased. Aviation regulators, responsible for safety oversight worldwide, now require airlines to focus on selecting pilots who are a good 'fit' for the airline (Bor et al., 2020) and emphasize the importance of competencies for aviation professionals (Tuncal & Çınar, 2024). Pilots are chosen not only for technical flight skills but also for non-technical skills (NOTECHS), such as situational awareness, decision-making, leadership, teamwork, and stress management. Recent studies examining the relationship between pilot selection and non-technical competencies (Goeters et al., 2004; Hedge et al., 2000; Hörmann et al., 2022; Ruff-Stahl et al., 2016) highlight the importance of these skills. The European Association of Aviation Psychology (EAAP) stated in its 2022 "*Selection in Aviation*" report that, while pilot selection criteria align with IATA's qualifications, the measurement and weighting of these competencies vary. Institutions should clarify how they weigh these measures in selection tools (Eaglestone et al., 2022). This proposition is in line with the requirement that each qualification criterion, from the beginner pilot to the licensed pilot, be weighted, as stated in the "*Pilot Aptitude Testing Guidance Material and Best Practices*" report published by IATA in 2019 (International Air Transport Association, 2019). However, IATA does not provide information regarding these measurement and weighting details. A review of the literature reveals that no study has been found to determine the weighting and importance level based on non-technical skills (NOTECHS) in the direct pilot selection process. The present study aims to determine the importance of non-technical skills that affect the human factor in pilot selection processes and how these skills should be weighted. Therefore, the competency dimensions actively used in pilot selection processes in an aviation company and included in the scope of the research were weighted with the Analytical Hierarchy Process (AHP).

2. Literature Review

Pilot selection has its roots in early 20th-century military aviation, shaped by the need for skilled pilots in warfare. Modern civil aviation selection processes begin with training and licensing, followed by tests in knowledge, psychomotor skills, group evaluations, simulator qualifications, and interviews (Zinn et al., 2019). Crew Resource Management (CRM) supports safe behaviors and now covers non-technical skills like situational awareness, decision-making, and fatigue management (IATA, 2023). CRM training expanded from its original scope to include broader human factors (Civil Aviation Authority, 2016).

Non-technical skills (NOTECHs), vital for professions requiring technical expertise, refer to cognitive and social abilities unrelated to aircraft control. Introduced by the European Joint Aviation Association (JAA), NOTECHs focus on areas like cooperation, leadership, and decision-making (Flin et al., 2008). These competencies, evaluated through the Advanced Qualifications Program (AQP) by the Federal Aviation Administration (FAA), are mandatory in the UK (Flin, 2010). ICAO defines eight core competencies, including communication, problem-solving, leadership, and workload management (Mansikka et al., 2017).

Studies conducted by Yazgan and Ustun (2011) and Yazgan and Erol (2016) classified pilot selection criteria into three main groups: technical, non-technical, and work-oriented. These studies determined that the most important criteria were intelligence, decision-making and problem-solving ability, and psychomotor skills, using the Analytical Hierarchy Process (AHP) technique. In addition, Oktal and Onrat (2020) and Mızrak (2023) identified flight skills, personality traits, and English language proficiency as the most critical criteria by weighting the pilot competencies defined by IATA and the evaluation criteria in the recruitment processes of civil aviation pilots. Similarly, Şimşek et al. (2022) emphasized that safe flight operations in the aviation sector, characterized by strict regulations and intense competition, depend on employing qualified human resources who can adapt to technology. Their research, which utilized the AHP method, focused on identifying the most suitable candidates in pilot recruitment processes by consulting senior pilots from the world's top 10 airlines. Based on the recommendations of experienced captains with managerial roles, 17 criteria (3 upper and 14 sub-criteria) actively used in the sector were weighted. As a result of their analysis, "technical," "non-technical," and "occupational criteria" were ranked as the upper criteria according to their importance based on local weights. In the context of the relevant literature, the following methodological paths were designed in this research.

3. Materials and Methods

The research aims to answer the following questions:

RQ1: What are the non-technical skills used in pilot selection processes, and how are these skills weighted according to flight phases?

RQ2: How do the weights of non-technical skills used in pilot selection processes change during flight phases such as pre-flight, take-off, cruise, approach and landing, and taxi?

RQ3: What non-technical competencies are considered most important in pilot selection processes?

There are two studies in the research. In the first study, nine non-technical competencies (*situation awareness, problem solving and decision making, teamwork, leadership, communication, controlling and managing emotions, planning, sense of duty, professional development*) used in pilot selection processes were identified and defined (Table 1). Competency dimensions utilized in this study were derived from the competency framework outlined in the International Air Transport Association's (IATA) (2019) document, *Competency Assessment and Evaluation for Pilots, Instructors, and Evaluators*. These competencies have been adapted and structured into a set comprising nine dimensions by a collaborative team of examiner pilots and academics currently working at an aviation company operating in Türkiye. This competency set is actively employed during the selection processes for first officer candidates within the company's assessment center framework.

Table 1. Non-technical Criterias and Explanations

Non-technical Criteria	Description
Situation Awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future (Endsley, 1988).
Problem Solving and Decision Making	The personnel working in high-risk sectors, under high-stress conditions and pressures originating from the need to make quick decisions in a very short time (Ceschi et al., 2019).
Teamwork	A dynamic process involving two or more professionals with complementary background and skills contributing in the most effective way to the overall tasks and goals of the team (Civil Aviation Safety Authority, 2019).
Leadership	In the context of influence, and explains how the leader should recognise the desires of the crew, set an example and use persuasion to create an understanding of goals that need to be met (ICAO, 2013)
Communication	The exchange of information, feedback or response, ideas and feelings (Flin et al., 2008).
Controlling and Managing Emotions	Provide a framework for both individual and organisational involvement in minimising stressful events and reactions (Flin et al., 2008).
Planning	Includes the processes of prioritization, resource management, alternative creation, time management, and plan control (Gontar & Hoermann, 2016).
Sense of Duty	It is the responsibility to perform one's duties effectively and ethically, which includes competencies such as business mastery, representativeness, self-discipline, compliance with rules and procedures, error awareness, and honesty (ICAO, 2010).
Professional Development	The process of continuously improving one's knowledge and skills through competencies such as resolving deficiencies/acquiring knowledge, motivation to learn, keeping one's knowledge up to date, being open to feedback, and learning from experiences.

To determine the weight of these competencies, the flight operation was divided into five basic flight phases. Scenarios were created for each flight phase based on real flight operations together with 5 Instructor Pilots. The criteria for selecting pilots during the scenario phase included having more than 10,000 hours of flight experience, being an Instructor, and having served in the assessment center of the relevant aviation company. These pilots did not participate in the weighting process. In the Evidence-Based Training document published by the International Civil Aviation Organization (ICAO) in 2013, it is stated that developing, training, and evaluating competencies using operational scenarios (ICAO, 2013). Additionally, Helmreich et al. (1999) suggested that rating flight crew behavior by flight phase. Table 2 lists the flight phases assigned for this research and the scenarios specific to each flight phase. Three sample scenarios are provided for each flight phase in the survey.

Table 2. Non-technical Criterias and Explanations

Phases	Sample Scenarios
Pre-flight	The pressurization system, which should have remained in automatic mode, was left in manual mode due to an item that was missed in the checklist during ground operation checks. Shortly after takeoff, everyone on board fainted.
Takeoff & Climb	The landing gear was forgotten to be retracted after takeoff. (*There is no after-take-off checklist in Airbus procedures.*)
Cruise	Suddenly, while flying over the ocean during a night flight, the fire alarms went off, and the flight crew could not identify the source of this warning for a while.
Approach and Landing	During a training flight, a first officer candidate, panicking and saying 'I can't land', let go of the controls. The captain pilot then safely landed the aircraft at the last moment.
Taxi-in	By following ATC (air traffic control) instructions to enter a taxiway not suitable for the wingspan, the aircraft veered off the taxiway and struck a tower in the grass area, resulting in a broken wing.

In the second study, sample scenarios were presented to 10 Examiner Pilots employed in the relevant aviation company via an online questionnaire and face-to-face interviews, and nine non-technical competencies for each flight phase were weighted using the Analytical Hierarchy Process technique.

The research model created is shown in the figure below (Figure 1):

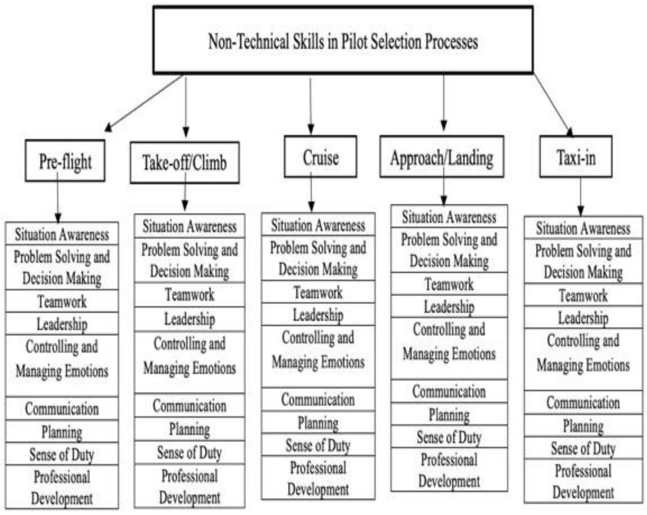

Figure 1. Research Model

Flight Examiners, as defined by the General Directorate of Civil Aviation (2024), are pilots authorized to carry out the tests and checks required for the issuance, revalidation, or renewal of any pilot license or rating. In addition to their administrative and technical duties, these experts, all of whom are instructor pilots, are evaluated to have a high level of competency in terms of pilot employment. Therefore, the sample group for this study consisted of Examiner Pilots. The data obtained was analyzed using the Analytical Hierarchy Process (AHP) analysis technique using Microsoft Excel 2016. During the analyses, we collaborated with a faculty member from the Numerical Methods Department, whose area of expertise is Multiple Decision Making Methods. During the consistency analysis, a participant who could not obtain evaluation findings in line with the consistency rate was removed from the sample group based on expert opinion.

4. Results

The demographic characteristics of the participants are presented in the Table 3. According to the demographic information in the table, all participants are male with an average age of 49.3. The participants' average flight hours were found to be 13200 hours, and their average flight seniority as examiner pilots was found to be 7 years.

Table 3. Demographic Characteristics

P	Gender	Education	Age	Status	TFH	TFY	YSEP
P1	Male	Air Force Academy	52	Examiner Pilot	13000	20+	7
P2	Male	Masters Degree	56	Examiner Pilot	18000	20+	15+
P3	Male	Bachelor's Degree	42	Examiner Pilot	10000	11-15	2
P4	Male	Air Force Academy	50	Examiner Pilot	15000	20+	8
P5	Male	Masters Degree	50	Examiner Pilot	15800	20+	4
P6	Male	Bachelor's Degree	55	Examiner Pilot	13000	20+	8
P7	Male	Air Force Academy	51	Examiner Pilot	9600	20+	4
P8	Male	Masters Degree	45	Examiner Pilot	13000	16-20	6
P9	Male	PhD	43	Examiner Pilot	12000	20+	10

P = Participants; **TFH** = Total Flight Hours; **TFY** = Total Flight Years; **YSEP** = Years of Seniority as Examiner Pilot

Weighting operations using the Analytic Hierarchy Process (AHP) according to upper and lower criteria were conducted through the following steps. To determine the local and global weights of each sub-criterion, (1) pair-wise comparison matrices were created, and (2) comparison matrices were normalized. Following these procedures, the priority vectors of the criteria in the hierarchical structure were determined, and their consistency was checked. This process was repeated for each flight phase.

4.1. Pre-flight Phase

The normalization process for the pre-flight phase criteria is shown in the table. Normalization was performed by dividing each element of the pair-wise comparison matrix by the total value of the column. The priority vector of each criterion was calculated by taking the average of the elements in each row of the normalized matrix (Table 4).

Table 4. Normalized Matrix and Priority Vector Values for the Pre-flight Phase

	C1	C2	C3	C4	C5	C6	C7	C8	C9	PV
C1	0.056	0.076	0.055	0.055	0.089	0.06	0.053	0.025	0.057	**0.058458**
C2	0.104	0.142	0.191	0.158	0.158	0.159	0.172	0.173	0.182	**0.160036**
C3	0.154	0.112	0.151	0.217	0.184	0.115	0.139	0.123	0.143	**0.148589**
C4	0.164	0.143	0.111	0.159	0.158	0.215	0.168	0.185	0.173	**0.164054**
C5	0.041	0.059	0.054	0.066	0.065	0.077	0.083	0.088	0.052	**0.064948**
C6	0.053	0.05	0.075	0.042	0.048	0.057	0.06	0.079	0.047	**0.056821**
C7	0.179	0.139	0.184	0.161	0.134	0.159	0.169	0.189	0.162	**0.163903**
C8	0.161	0.059	0.088	0.062	0.053	0.051	0.064	0.072	0.096	**0.078398**
C9	0.087	0.221	0.092	0.081	0.11	0.106	0.092	0.066	0.088	**0.104792**

Criteria: C1: Sense of Duty, **C2:** Situation Awareness, **C3:** Problem Solving and Decision Making, **C4:** Teamwork, **C5:** Leadership, **C6:** Professional Development, **C7:** Communication, **C8:** Controlling and Managing Emotions, **C9:** Planning; **PV:** Priority Vector

In the table below, the pre-flight phase criteria are shown along with the calculated consistency index (Table 5). To ensure an acceptable consistency ratio (CR), the CR value must be 0.1 or less than 0.1.

Table 5. Consistency Ratio for Pre-flight Phase

Landa Max	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
9.43295	0.054118614	1.45	**0.037323182** < 0.10

While calculating the overall weight, the priority vector of the main criterion to which the sub-criterion belongs is multiplied by the sub-criterion's own (local) priority vector. The table below lists the general weights and order of importance for the pre-flight phase (Table 6).

As a result of the calculations, the most important criteria in the pre-flight phase are leadership (0.03281), sense of duty (0.03278), problem solving and decision making (0.03200), respectively. Communication has the least importance at this stage with 0.01136.

Table 6. The Order of Importance of the Pre-flight Phase Factors

Pre-flight Phase	Leadership	**0.03281**
	Sense of Duty	**0.03278**
	Problem Solving and Decision Making	**0.03200**
	Teamwork	**0.02971**
	Planning	**0.02095**
	Controlling and Managing Emotions	**0.01567**
	Professional Development	**0.01298**
	Situation Awareness	**0.01169**
	Communication	**0.01136**

4.2. Take-off/Climb Phase

The priority vector of each criterion was calculated by taking the average of the elements in each row of the normalized matrix (Table 7).

Table 7. Normalized Matrix and Priority Vector Values for the Takeoff/Climb Phase

	C1	C2	C3	C4	C5	C6	C7	C8	C9	PV
C1	0.054	0.054	0.033	0.033	0.051	0.04	0.08	0.083	0.105	**0.059143**
C2	0.201	0.201	0.328	0.228	0.225	0.134	0.199	0.197	0.189	**0.211268**
C3	0.182	0.069	0.112	0.092	0.198	0.17	0.122	0.099	0.16	**0.133746**
C4	0.181	0.096	0.133	0.109	0.068	0.115	0.098	0.128	0.105	**0.11466**
C5	0.096	0.08	0.051	0.144	0.089	0.062	0.105	0.11	0.093	**0.092126**
C6	0.076	0.083	0.036	0.053	0.079	0.055	0.061	0.035	0.035	**0.057076**
C7	0.103	0.153	0.139	0.168	0.129	0.137	0.151	0.15	0.148	**0.141991**
C8	0.061	0.095	0.105	0.079	0.075	0.149	0.094	0.093	0.077	**0.091882**
C9	0.046	0.17	0.062	0.093	0.086	0.139	0.091	0.107	0.089	**0.098108**

Criteria: C1: Sense of Duty, **C2:** Situation Awareness, **C3:** Problem Solving and Decision Making, **C4:** Teamwork, **C5:** Leadership, **C6:** Professional Development, **C7:** Communication, **C8:** Controlling and Managing Emotions, **C9:** Planning; **PV:** Priority Vector

In the table below, the take-off/climb phase criteria are shown along with the calculated consistency index (Table 8).

Table 8. Consistency Ratio for Takeoff/Climb Phase

Landa Max	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
9.46203	0.057754588	1.45	**0.039831** < 0.10

The table below lists the general weights and order of importance for the take-off/climb phase (Table 9).

In the calculations made in the take-off/climb phase, problem solving and decision making (0.04225) and sense of duty (0.02839) are the most important criteria. Situation awareness 0.01182 and communication 0.01141 have the least importance at this stage.

Table 9. The Order of Importance of the Take-off/Climb Phase Factors

Take-off/Climb Phase	Problem Solving and Decision Making	**0.04225**
	Sense of Duty	**0.02839**
	Teamwork	**0.02674**
	Leadership	**0.02293**
	Planning	**0.01962**
	Professional Development	**0.01842**
	Controlling and Managing Emotions	**0.01837**
	Situation Awareness	**0.01182**
	Communication	**0.01141**

4.3. Cruise Phase

The priority vector of each criterion was calculated by taking the average of the elements in each row of the normalized matrix (Table 10).

Table 10. Normalized Matrix and Priority Vector Values for the Cruise Phase

	C1	C2	C3	C4	C5	C6	C7	C8	C9	PV
C1	0.064	0.068	0.033	0.069	0.072	0.049	0.068	0.094	0.072	**0.065467**
C2	0.217	0.227	0.45	0.363	0.218	0.21	0.217	0.236	0.195	**0.259303**
C3	0.245	0.064	0.126	0.162	0.222	0.153	0.165	0.165	0.14	**0.160237**
C4	0.08	0.053	0.067	0.085	0.104	0.138	0.102	0.127	0.124	**0.097811**
C5	0.06	0.07	0.038	0.055	0.067	0.092	0.071	0.072	0.086	**0.067989**
C6	0.064	0.053	0.041	0.03	0.036	0.049	0.047	0.051	0.05	**0.046915**
C7	0.157	0.175	0.128	0.139	0.158	0.173	0.167	0.137	0.154	**0.154147**
C8	0.049	0.069	0.055	0.048	0.067	0.068	0.087	0.072	0.11	**0.069415**
C9	0.063	0.221	0.063	0.048	0.055	0.068	0.076	0.046	0.07	**0.078716**

Criteria: C1: Sense of Duty, **C2:** Situation Awareness, **C3:** Problem Solving and Decision Making, **C4:** Teamwork, **C5:** Leadership, **C6:** Professional Development, **C7:** Communication, **C8:** Controlling and Managing Emotions, **C9:** Planning; **PV:** Priority Vector

In the Table 11, cruise phase criteria are shown along with the calculated consistency index.

Table 11. Consistency Ratio for Cruise Phase

Landa Max	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
9.52060	0.065075962	1.45	**0.044879974** < 0.10

The table below lists the general weights and order of importance for the cruise phase (Table 12).

In the calculations made for the cruise phase, situation awareness 0.05186 is identified as the most important criterion. Professional Development has the least importance rating at this stage, with a value of 0.00938.

Table 12. The Order of Importance of the Cruise Phase Factors

Cruise Phase	Situation Awareness	**0.05186**
	Problem Solving and Decision Making	**0.03204**
	Communication	**0.03082**
	Teamwork	**0.01956**
	Planning	**0.01574**
	Controlling and Managing Emotions	**0.01388**
	Leadership	**0.01359**
	Sense of Duty	**0.01309**
	Professional Development	**0.05186**

4.4. Approach/Landing Phase

The priority vector of each criterion was calculated by taking the average of the elements in each row of the normalized matrix (Table 13).

Table 13. Normalized Matrix and Priority Vector Values for the Approach/Landing Phase

	C1	C2	C3	C4	C5	C6	C7	C8	C9	PV
C1	0.052	0.049	0.031	0.038	0.047	0.101	0.065	0.072	0.058	**0.056874**
C2	0.262	0.248	0.384	0.337	0.309	0.214	0.348	0.239	0.253	**0.288149**
C3	0.253	0.096	0.149	0.159	0.212	0.102	0.165	0.127	0.215	**0.164237**
C4	0.131	0.07	0.089	0.095	0.112	0.131	0.068	0.137	0.101	**0.103672**
C5	0.07	0.051	0.044	0.053	0.063	0.071	0.068	0.086	0.084	**0.065747**
C6	0.026	0.059	0.075	0.037	0.045	0.051	0.052	0.027	0.036	**0.045528**
C7	0.105	0.093	0.117	0.181	0.121	0.129	0.131	0.182	0.137	**0.132924**
C8	0.042	0.061	0.068	0.04	0.043	0.11	0.042	0.058	0.052	**0.057268**
C9	0.057	0.273	0.044	0.06	0.048	0.091	0.061	0.072	0.064	**0.085602**

Criteria: C1: Sense of Duty, **C2:** Situation Awareness, **C3:** Problem Solving and Decision Making, **C4:** Teamwork, **C5:** Leadership, **C6:** Professional Development, **C7:** Communication, **C8:** Controlling and Managing Emotions, **C9:** Planning; **PV:** Priority Vector

In the table below, approach/landing phase criteria are shown along with the calculated consistency index (Table 14).

Table 14. Consistency Ratio for Approach/Landing Phase

Landa Max	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
9.69169	0.086461943	1.45	**0.059628926** < 0.10

The table below lists the general weights and order of importance for the approach/landing phase (Table 15).

In the weighting calculations for the approach/landing phase, situation awareness (0.06228) is the most important criterion. This importance is followed by problem solving and decision making (0.02896) and teamwork (0.01993). Professional Development has the least importance rating at this stage, with a value of 0.00899

Table 15. The Order of Importance of the Approach/Landing Phase Factors

Approach/Landing Phase	Situation Awareness	**0.06228**
	Communication	**0.02966**
	Problem Solving and Decision Making	**0.02896**
	Teamwork	**0.01993**
	Planning	**0.01594**
	Leadership	**0.01322**
	Sense of Duty	**0.01069**
	Controlling and Managing Emotions	**0.01029**
	Communication	**0.01141**

4.5. Taxi-in Phase

The priority vector of each criterion was calculated by taking the average of the elements in each row of the normalized matrix (Table 16).

Table 16. Normalized Matrix and Priority Vector Values for the Taxi-in Phase

	C1	C2	C3	C4	C5	C6	C7	C8	C9	PV
C1	0.054	0.054	0.033	0.033	0.051	0.04	0.08	0.083	0.105	**0.059143**
C2	0.201	0.201	0.328	0.228	0.225	0.134	0.199	0.197	0.189	**0.211268**
C3	0.182	0.069	0.112	0.092	0.198	0.17	0.122	0.099	0.16	**0.133746**
C4	0.181	0.096	0.133	0.109	0.068	0.115	0.098	0.128	0.105	**0.11466**
C5	0.096	0.08	0.051	0.144	0.089	0.062	0.105	0.11	0.093	**0.092126**
C6	0.076	0.083	0.036	0.053	0.079	0.055	0.061	0.035	0.035	**0.057076**
C7	0.103	0.153	0.139	0.168	0.129	0.137	0.151	0.15	0.148	**0.141991**
C8	0.061	0.095	0.105	0.079	0.075	0.149	0.094	0.093	0.077	**0.091882**
C9	0.046	0.17	0.062	0.093	0.086	0.139	0.091	0.107	0.089	**0.098108**

Criteria: C1: Sense of Duty, **C2:** Situation Awareness, **C3:** Problem Solving and Decision Making, **C4:** Teamwork, **C5:** Leadership, **C6:** Professional Development, **C7:** Communication, **C8:** Controlling and Managing Emotions, **C9:** Planning; **PV:** Priority Vector

In the table below, taxi-in phase criteria are shown along with the calculated consistency index (Table 17).

Table 17. Consistency Ratio for Taxi-in Phase

Landa Max	Consistency Index (CI)	Random Index (RI)	Consistency Ratio (CR)
9.46203	0.057754588	1.45	**0.039831** < 0.10

The table below lists the general weights and order of importance for the approach/landing phase (Table 18).

Table 18. The Order of Importance of the Taxi-in Phase Factors

Taxi-in Phase	Situation Awareness	**0.05763**
	Problem Solving and Decision Making	**0.03284**
	Communication	**0.02658**
	Teamwork	**0.02073**
	Planning	**0.01712**
	Leadership	**0.01314**
	Controlling and Managing Emotions	**0.01145**
	Sense of Duty	**0.01137**
	Professional Development	**0.00910**

In the weighting calculations for taxi-in phase, situation awareness (0.05763) is identified as the most important criterion. This is followed by problem solving and decision making 0.03284. Professional Development (0.00899) and sense of duty (0.01137) have the least importance at this stage.

Finally, within the scope of the third research question, examiners scored non-technical skills with the AHP technique according to their importance in the pilot selection process, regardless of the flight phases. The global weights of the data were calculated, and the importance levels are listed below (Table 19). In the weighting calculations, situation awareness 0.13365 is identified as the most important criterion among all criteria, including non-technical skills. Planning has the least important level, with an overall severity level of 0.10206.

Table 19. The Order of Importance of the Non-technical Criteria for Pilot Selection Process

Criteria	Situation Awareness	**0.13365**
	Problem Solving and Decision Making	**0.11497**
	Sense of Duty	**0.11240**
	Communication	**0.11223**
	Professional Development	**0.11095**
	Controlling and Managing Emotions	**0.10907**
	Leadership	**0.10233**
	Teamwork	**0.10231**
	Planning	**0.10206**

5. Discussion

Weightings were determined using the Analytical Hierarchy Method (AHP) within the context of sample scenarios presented to 10 Examiner Pilots working in human resources, personnel selection, and pilot licensing duties in an aviation company. As a result of consistency ratio calculations, the importance levels of non-technical criteria for each flight phase were determined based on the general and local weights obtained by considering the scoring scores of nine participants. Situation awareness competency, which is predominant in three of the evaluated phases and in the overall weighting, is recognized as one of the most critical and essential skills for flight missions and flight crews. This finding aligns with the finding that situation awareness is the most critical skill during the approach, landing, and taxi phases (Shook et al., 2000). When examining general aviation accidents, the primary causes are largely attributed to the loss of situation awareness (Hunter, 1995; National Transportation Safety Board, 1989). This is particularly evident in the pre-flight phase, where gathering information and planning related to the flight it conditions (such as weather, air traffic control, airport location) are crucial. It is assumed that improving these evaluation behaviors (Prince and Salas, 1993) will enhance overall safety. Situation awareness, recognized as a critical competency in pilot selection processes (Helmreich and Foushee, 2019; Goeters et al., 2004; Gontar and Hoermann, 2014; Ruff-Stahl et al., 2016), directly impacts flight operation efficiency and performance today. Problem-solving and decision-making skill, which rank as the second most important in the weightings, represent a systematic approach to the cognitive process by which pilots select the best course of action in response to a given set of situations. In-flight decision-making was a contributing factor in 10% of all accidents (62) between 2012 and 2021 (International Air Transport Association, 2020). In addition to these two competencies, communication skills, which are highly ranked and considered fundamental for pilots by authorities, can also lead to a loss of situational awareness among team members and harm teamwork, as 60-70% of aviation accidents are attributed to communication failures (Federal Aviation Administration, 2004; International Air Transport Association, 2020). The Sully Accident, which is prominently discussed in the literature and based on decision-making skills and communication skills, serves as a prime example of this. In this incident, the pilots had to make a forced landing in the Hudson River after both engines failed. The effective application of CRM and efficient communication between cockpit-cockpit and cockpit-air traffic control (ATC) resulted in a safe landing with no fatalities (National Transportation Safety Board, 2010). Research findings (Salas et al., 2008; Sexton et al., 2000) in the literature indicate that teamwork and collaboration, which are other prominent competencies, are associated with the performance of pilots. Airline pilots are trained in high levels of collaboration and team building. (Goeters, 2004). The reason for this emphasis is that effective intervention strategies to prevent conflicts are closely related to teamwork. Overall, research conducted by Ruff-Stahl et al. (2016) shows that it is possible to score entry-level student pilots on non-technical skills (NOTECHS), which was initially designed as a renewal assessment tool for trained airline pilots.

6. Conclusion

NOTECHS method provides clear and individually discernible results for each candidate, which can serve as an assessment of the individual's CRM ability. The clarity and transparency of the results regarding CRM capability make NOTECHS an easily understandable tool, even for non-psychologists. Therefore, this framework offers great usability to Human Resources personnel and airline pilots in the selection of their future colleagues. As a result of this research, a new model for personnel selection processes has been proposed for the aviation industry, one of the most risky and competitive sectors. This proposed model can be used in the pilot candidate selection processes of an aviation company operating in the aviation company and is also considered an important reference for flight schools and airline company managers. Furthermore, the model has the potential to be effectively utilized during Crew Resource Management (CRM) interview stages, providing a structured framework for assessing non-technical skills critical to aviation safety and operational efficiency.

7. Limitations and Future Directions for Research and Practice

This study evaluated the effectiveness of the Analytical Hierarchy Process (AHP) method in the selection process of pilot candidates. However, the study was limited to the pilot examiners in the assessment center of a specific airline company, which restricts the generalizability of the results. Future research should be conducted across different airlines and cultural contexts to enhance generalizability and should utilize more objective data collection methods such as observation and experimentation to mitigate participant bias. Given the AHP method relies on subjective judgments, combining it with other decision-making methods can reduce its limitations. Future studies should focus on evaluating both technical and non-technical skills in pilot selection processes and on assessing the long-term performance of selected candidates to compare the effectiveness of the selection processes. Research on the use of simulation technologies and artificial intelligence in pilot selection processes will help discover innovative and effective methods. Finally, investigating the effects of different cultural and psychological factors on the performance of pilot candidates will help optimize selection processes with cultural sensitivity. Future research conducted with these limitations and recommendations will contribute to a more scientific and effective selection process for airline pilot candidates.

Ethical approval

The studies involving human participants were reviewed and approved by the Istanbul University Research Ethics Committee (IUREC 356/2022). The participants provided their written informed consent to participate in this study.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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