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Research on Flight Professional Spirit and Skill Capability Based on Human Factors Analysis Model

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Abstract: The professional spirit and skill capability of pilots are directly related to flight safety. In this study, 36 typical Cina civil aviation flight incidents caused by crew responsibility from January 2017 to June 2019 were taken as the research objects. After using the human factor analysis model, the study had deeply analyzed the typical problems of flight professional spirit and skill capability, and put forward the corresponding measures for the industry and airline.

1. Introduction

While the development of modern civil aviation technology, human factors have become the main factor of various unsafe events, and the professional spirit and skill capability of flight teams are directly related to flight safety.

As early as 2011, the National Transportation Safety Board (NTSB) noted that the occurences have reached a" disturbing number" due to the pilots and controllers are not following standard operating procedures. The NTSB cited a "decline in professionalism", and urged measures to improve the performance of front-line workers. That's why the NTSB added "pilot and controller professionalism" to its new list of “the 10 most urgent improvements” to prevent aviation and other transportation accidents that year[1].

In China, the same problems about professional spirit and skill capability also exist. In 2018, China Civil Aviation cleared that the professional spirit and skill capability of the flight crew should be strengthened to ensure the safe, stable and controllable operation of civil aviation. In the same year, the Civil Aviation Administration of China (CAAC) issued the advisory circular "Flight Operation professional spirit" (AC-121-FS-2018-130)[2], and carried out publicity and education activities on pilots to promote the safety quality. Also, in China, it is becoming the general consensus

of the whole industry that good professional spirit and skill capability should be maintained throughout a pilot's career.

However, with the continuous and rapid development of the industry, the "metabolism" of employees is accelerated, and it is more difficult to construct professional spirit and skill capability. It is found from the recent years incidents caused by flight crew that the problems of professional spirit and skill capability are growing and highlighting.

2. Statistical Summary of incidents caused by Flight Crew

Through the analysis of unsafe events from January 2017 to June 2021[1], the study found that more than 5000 events happened in China Civil Aviation, and about 10% events caused by transportation flight crew responsibility. Among them, there are 59 incidents occured, including 23 severe incidents and 36 general incidents.

The statistical overview of these incidents is shown in Figure 1 (classification by event type) and Figure 2 (classification by occurrence stage).

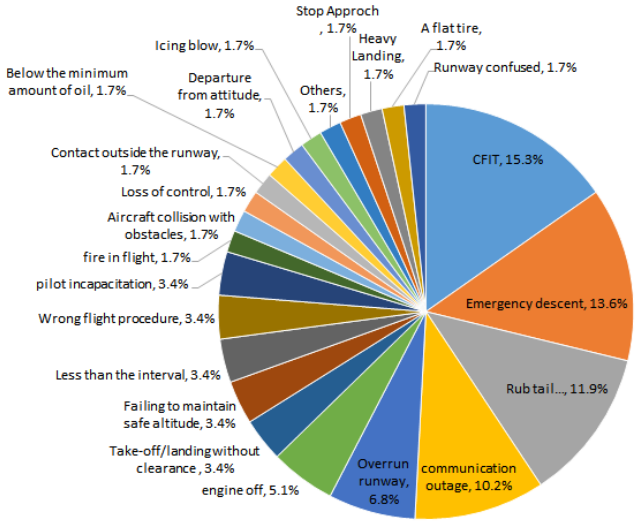

Figure 1: Classification by event type on flight crew incidents

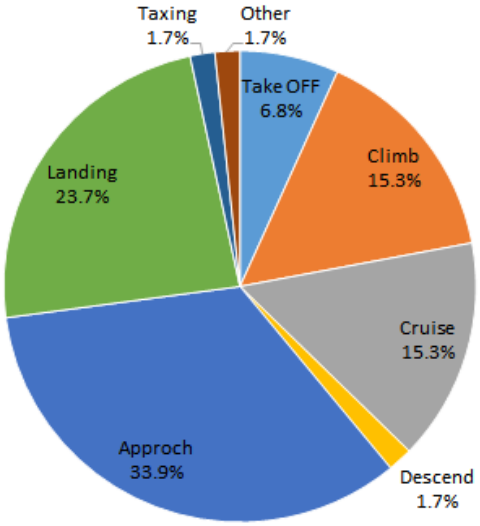

Figure 2: Classification by occurrence stage on flight crew incidents

[1]The Date from Aviaiton Safety Information System

It can be seen from Figure 1, the main types of flight crew cause incidents are CFIT, emergency descent, tail rub/engine/wing and communication outage, these incidents type are accounting for 50.8% of the total incidents caused by flight crew.

In addition, the Figure 2 showed that the flight crew's incidents mainly occurred in the approach and landing stage which accounting for 57.6% of the total, followed by the climbing and cruise stage that accounts for 30.5%.

3. Analysis of the Professional Spirt and Skill capability of Flight Crew in China

3.1. Defination of professional spirt and skill capability based on human factor analysis model

Professional Spirt refers to the attitude and behavior of flight crew in flight, mainly about the psychological identification and external reaction to various normative standards that stipulate and guide flight. But Skill capability refers to the ability that the pilot must immediately evaluate and distinguish the real-time or potential conditions to be presented, and take the most appropriate operations or measures to make the aircraft move continuously in three-dimensional space.

According to the Swiss cheese (Reason) model[3], accident or incident is the performance of the final results. The safety level lies in whether the front of each risk control measures makes effectively. Therefore, as the final part of risk control, the unsafe behavior control of flight crew is the most direct and critical. According to the human Factor Analysis and Classification System (HFACS) model[4][5], unsafe behaviors can be further divided into violation and error, and the error can be further divided into technological error, decision-making error and cognitive error.

Obviously, the unsafe behaviors of the flight crew are directly related to the professional spirt and skill capability of the flight crew. In this study, the violation of regulations is reflected as a significant professional spirt problem, and all kinds of errors are reflected as a skill capability problem.

Applying the human factor analysis model to define professional spirt and skill capability, the study makes a deeper anaysis on the 36 incidents caused by flight crew in total from January 2017 and June 2019. Figure 3 shows the frequency of all kinds of unsafe behaviors in that period.

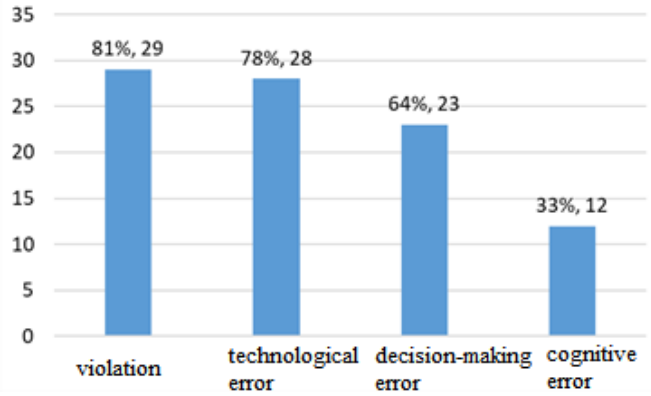

Figure 3: Frequency of all kinds of unsafe behaviors

As can be seen from Figure 3, violations of rules and regulations were found in 29 cases, accounting for 81% of the total incidents. And there were 28 cases existing technological error, accounting for 78% of the total. There were 23 cases of cognitive error, accounting for 64% of the total. There were 12 incidents with decision-making error, accounting for 33% of the total[2].

[2]Different unsafe behaviors may occur in one incident, so the sum of the numbers in the figure is greater than 36, and the sum of the frequencies is greater than 1.

After in-depth analysis of the above data, it is concluded that the problem of professional spirt and skill capability of China civil Aviation are mainly reflected in the following aspects.

3.2. Lack of respect for regulations

Pilot's violation will lead to the ineffectiveness of the regulations protection and bring safety risks. In recent years, most of the unsafe events in China's civil aviation are related to pilots' negligence, deviation from standards or normal procedures. The study further analyzes the 29 cases involving violations, and the main behaviors of violations are extracted. The statistical results are shown in Figure 4.

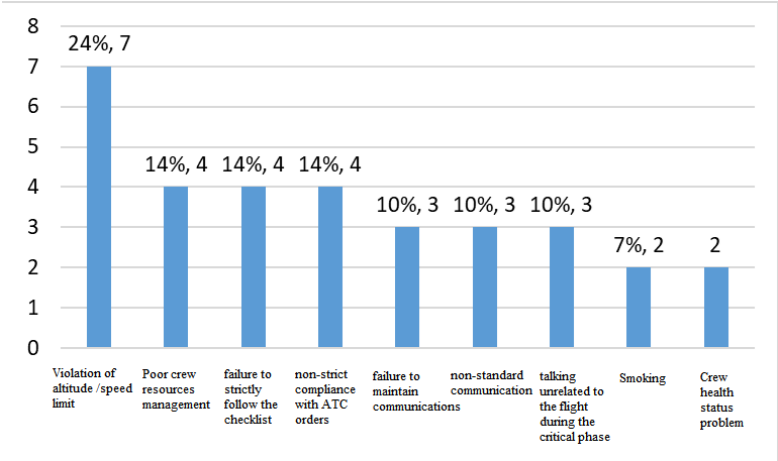

Figure 4: Statistical chart of violations according to specific behavior factors

As can be seen from Figure 4, it shows that :

● Altitude and speed limits were violated in 7 incidents, accouting for 24% of the total. The specific behaviors are as follows: landing below the minimum altitude; The transition height was not checked during descent preparation; Altitude and speed requirements for starting approach anchor point are not complied with.

● Poor crew resources management was associated with 4 incidents, accounting for 14% of the total. The specific performances are: copilot violation rest; the captain did not assign other personnel to enter the cockpit before leaving the cockpit.

● 4 incidents were related to failure to strictly follow the checklist, about 14% of the total. The specific manifestations are: the approach check list is not executed; the inspection list did not verify the actual status of the aircraft system and do the requirements of a question and answer.

● 4 incidents were related to non-strict compliance with ATC orders, accounting for 14% of the total. The specific performances are: breaking the height of control order; not following departure route as instructed by ATC, etc.

● 3 incidents, about 10% of the total, were related to failure to maintain communications as required. Specific performances are: not wearing headphones; Emergency frequency is not effective holding, etc.

● 3 events were associated with non-standard communication, accounting for 10% of the total. The specific performances are: not strictly implement the "receive manipulation" standard communication; the go around operation did not follow the standard communication as manual procedure required.

● In 3 incidents, about 10% of the total, the crew talked about something unrelated to the flight during the critical phase. Specific performanceas are: pilots were talking in the phone during the engine start; Part of the conversation in cockpit has nothing to do with the flight after the approach.

3.3. Decline in flight manual control skills

Aircraft technology innovation has made the aircraft's automation level is higher and higher, but the consequent is the manual operation ability decline of pilot in actual flight, it has become a common problems in the world.The study further analysis the reason of the 28 cases involving technical errors and extract the primary skill defect, the results as shown in figure 5.

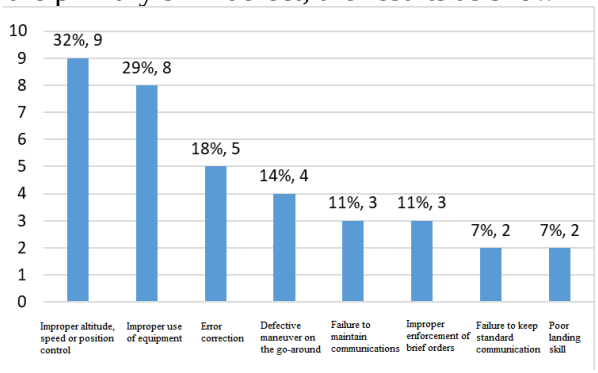

Figure 5: Statistical chart of technological capability according to specific behavior factors

As can be seen from Figure 5, it shows that :

● Improper altitude, speed or position control are associated with 9 incidents, accounting for 32% of the total. The specific manifestations are as follows: improper management of height to distance ratio and energy of aircraft; Deviation from standard track; The timing and method of adjusting the target height are incorrect.

● Improper use of equipment was associated with 8 incidents, about 29 % of the total. The specific manifestations are: improper use of airborne computer, failed to timely input the correct waiting route into the computer; An error in shutting down the air conditioning unit during the execution of the engineless airbleed takeoff supplement; Failure to use navigation equipment to control aircraft altitude, etc.

● Error correction was found in 5 cases, accounting for 18% of the total. The specific behaviors are: excessive deviation correction; Deviation correction is not timely, etc.

● 4 incidents, about 14% of the total, were characterized by defective maneuver on the go-around. The specific manifestations are: the go around control action is not standardized; The go-around thrust is not set.

● Failure to maintain communications as required was associated with 3 incidents, accounting for 11% of the total. The specific performances are: communication language is not standard, monitoring is not standard.

● Improper enforcement of brief orders was associated with 3 events, accounting for 11% of the total. The specific performances are: failed to complete the approach brief; Failure to complete supplemental briefs after changes to runway and departure procedures, etc.

3.4. Poor active learning ability

In addition to mastering operational skills and basic flight theory, an outstanding pilot should also understand relevant aviation knowledge, such as aircraft structure, aircraft system, flight principle, aerodynamics, aircraft performance, meteorological theory, airport operation and aviation medicine, etc. But in practice, most pilots still fall short of these requirements.

The study further analyzed 23 aircrew incidents involving cognitive errors and extracted the main types of cognitive errors, which also fully reflected the lack of active learning ability of a few pilots. The statistical results are shown in Figure 6.

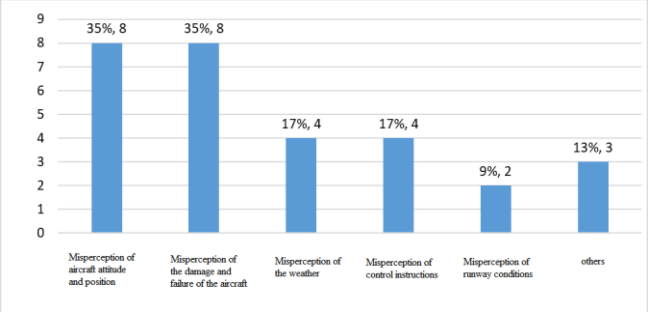

Figure 6: Statistical chart of cognative capability according to specific behavior factors

As can be seen from Figure 6, it shows that :

● 8 incidents were related to misperception of aircraft attitude and position, accounting for 35% of the total. The specific manifestations are: misjudgment of aircraft attitude, misjudgment of aircraft altitude and descent trend, loss of position consciousness and so on.

● 8 incidents, 35% of the total, were related to the crew's misperception of the damage and failure of the aircraft. The specific manifestations are: misjudging the runway water skiing phenomenon as brake failure, misjudging the stall warning as speeding warning, misjudging the tail brush as snow hitting the rear of the fuselage, etc.

● 4 incidents, about17% of the total, were associated with misperception of the weather. Specifically, it fails to comprehensively evaluate the adverse effects of complex weather on approach and landing, and fails to fully analyze and grasp the development trend of airport weather, etc.

● Misperception of control instructions was associated with 4 incidents, accounting for 17% of the total. Specifically, the pilots misinterpreted the controller's instruction of 2,200 meters as 2,200 feet and misheard the controller's instruction.

● 2 incidents were associated with misperception of runway conditions, accounting for 9% of the total. The specific performances are: Too good expectation on the wet track surface braking effect, think the runway side lights as the center line lights.

● 3 cases were associated with other types of cognitive errors, accounting for 13% of the total. The specific manifestations are: the failure to realize the communication interruption after the specified time, the failure to find the main frequency error in time after frequency hopping, etc.

3.5. Insufficient emergency reaction capacity

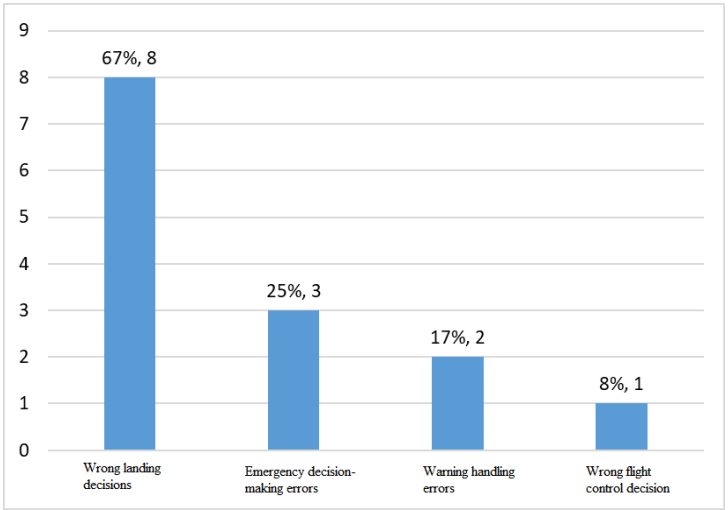

Figure 7: Statistical chart of decision-making capability according to specific behavior factors

At any moment during the flight, the pilot should be clear about the motion state of the aircraft and the flight-related situation, that is, real-time "situational awareness" is required. The lack of situational awareness capability is reflected in the insufficient ability of pilots to acquire, understand, judge and use information, especially in complex environments, which highlights the lack of emergency response capability of aircrews.

The study further analyzes 12 incidents involving decision-making errors, and extracts the types of decision errors. The statistical results are shown in Figure 7.

As can be seen from Figure 7, it shows that :

● 8 incidents were related to landing decisions, accounting for 67% of the total. The specific manifestations are: continuing to descend when landing conditions are not available, continuing to fly in unsafe conditions, and failing to make a timely return flight, etc.

● 3 incidents were related to emergency decision-making, accounting for 25% of the total. Specific performances include: not to take emergency evacuation measures, suspected wiping tail did not execute "wiping tail" checklist, etc.

● 2 incidents were related to warning handling errors, accounting for 17% of the total. The specific manifestations are: the flight path was not adjusted according to the "TERRAIN AHAED" disposal procedure in the quick inspection list; and the flight did not go around in time during the TERRAIN warning was triggered, etc.

● 1 incident (8%) was related to the wrong flight control decision. The specific performance is: when correcting the altitude deviation, the wrong method is chosen, resulting in the aircraft flying into the complex terrain area.

4. Suggestions on strengthening Professional Spirt and Skill capability

"It was my life that brought me down safely in the Hudson River," Captain Sully wrote in "Highest Duty"[6]. A professional pilot should not only have superb flying skills, extensive knowledge, certain management and coordination skills and judgment accumulated from flying experience, but also have a unremitting pursuit of flying and excellence.

According to the data analysis, this study puts forward the following suggestions:

● Strengthen the implementation of rules and standards, focus on compliance, and improve the sense of responsibility

Good professional spirt is based on strict compliance with rules and regulations. Cultivating a good professional spirt is to start from the word "strict", "strict" in the implementation of the rules and regulations, "strict" in the standardized procedural operation of the aircraft, "strict" in the company to implement the safety management system.

● Enhance basic maneuvering ability, focusing on landing maneuvering ability

The FOQA data of flight quality monitoring are applied to the training process of pilot personnel, and the differentiated training of different personnel is formulated according to the personal characteristics[7]. Strengthen the training of basic skills of the flight crew, reduce the dependence of automatic equipment in the simulator training, and increase the proportion of manual control time.

● Continuously improve self-learning ability

To strengthen pilots' learning and understanding of flight regulations, standard operation and safety connotation. Pilots need to actively study the airplane flight manual, SOP, regulations, rules and policies formulated by the certificate holder and related documents, take an active part in safety experts, technical experts, business backbone for flight project, new technology, new knowledge, consciously in-depth study, constantly improve their own technical level and safety management ability.

● Enhance emergency response ability training

The pilots need to enhance flight crew's cognitive ability on different scenarios, such as special weather, special airport, airport facilities fault, runway changes, aircraft fault and emergency warning situation, and learn the knowledge of the spatial orientation and situational awareness, and do the training of internal and external standardization communication, labor coordination division to increase real emergency disposal ability.

5. Conclusions

After analysis on the 36 incidents caused by flight crew, the research uses the human factor analysis model to distinguish the pilot's professional spirt and skill capability, so the weak links of flight crew can be seen intuitively. In the end, the study put forward the characters of an excellent pilot are the consciousness and responsibility of abiding regulations and keeping discipline, excellent flight control ability, good situational awareness and emergency response ability, and continuous active learning ability.

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