

Perception of Causal Factors in Flight Operations Between Ab-Initio and Expatriate Pilots

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Abstract— The establishment of objectives in organizational safety management systems (SMS) are dependent on how the workforce perceives hazards and deficiencies. In the Asia region, it is common for airlines to recruit pilots through both ab-initio cadet programs, as well as to hire experienced expatriates from predominantly Western countries. When the workforce contains a mix of cultures and training backgrounds, perceptual differences may affect the relevance of SMS objectives and the effectiveness of consequential safety interventions. The present research compared experienced airline pilots from Asian ab-initio backgrounds with their Western, expatriate counterparts on the attribution of safety conditions related to hierarchical relations, organizational faults, human performance limitations, external faults, and human-machine interface conflicts. It was discovered that cultural values on interpersonal relations, desire for guidance, and social distance to an ‘in-group’ influenced the classification of safety deficiencies. The findings encourage SMS practitioners to include a wider diversity of perspectives when carrying out organizational SMS processes.

Keywords—safety management systems, HFACS, ab-initio pilots, cadet pilots, culture differences

I. INTRODUCTION

A. Airline Safety Management in the Asian Context

Civil aviation safety has continuously improved in Asia with the serious accident rate of air carriers in the North Asia and Asia Pacific regions below the world average (IATA, 2023). Yet, as demand for air travel is expected to grow rapidly in the region, academic researchers have identified the need to pre-emptively improve the effectiveness of safety management systems (Sun & Wang, 2016). Within organisations, Safety Management System (SMS) functions are responsible for the management of systemic threats through four major elements of Safety Policy and Objectives, Safety Risk Management, Safety Assurance, and Safety Promotion (ICAO, 2018). The identification of safety hazards and deficiencies is of particular importance because the detected hazards and deficiencies form the basis on which safety policies and objectives are formed. These in turn will determine the types of interventions that are implemented, such as modifications to crew training and/or other preventative measures.

SMS processes are more likely to be successful if the elements are considered to be more relevant and acceptable by the target audience (Chan & Li, 2021). Within the airline pilot profession, however, the target audience may have varying characteristics. In many Asian countries which are experiencing rapid growth in air travel, the pilot workforce

can generally be divided into two groups of either domestic airline-sponsored cadets, or foreign expatriates who joined the airline with previous experience in their own countries. For example, industry forecasts predict that China requires between 126,000 to 134,000 new pilots in the 20 years between 2022 and 2041 (Airbus, 2022; Boeing, 2022). With the domestic pilot training industry unable to satisfy this demand, Chinese air carriers have been hiring foreign pilots to supplement their ranks (Laboda, 2018). Many airlines have also developed ab-initio pilot training programmes, where the airline would select candidates with no or little previous aeronautical experience and sponsor their pilot training at the airline’s own or contracted pilot academies (Turner, 2014).

B. Cultural Differences Between Ab-Initio Airline Cadets and Foreign Expatriate Pilots

Even after a few years post-training and the ab-initio cadets gain a level of proficiency and experience that is comparable with their foreign colleagues, there may still be cultural differences between the two groups because of their different understanding of regulations and policies. This can lead to variations in the attribution of active failures and latent conditions to different parts of an organisation, affecting the selection of SMS objectives. Cultural differences in the attribution of human factors conditions have been established in previous studies using the Human Factors Analysis and Classification System (HFACS). The HFACS is an analytical framework providing categories in which safety deficiencies can be classified over four organizational levels ranging from operators at the ‘sharp end’, through managerial levels, to higher-level supervisory and organizational conditions (Wiegmann & Shappell, 2003).

A comparison of Chinese and British participants’ analysis of identical accident causal factors using HFACS found British participants to be more likely to attribute ‘adverse mental state’ conditions, whereas Chinese participants opted for ‘perceptual error’ (Li et al., 2007). This was reflective of the Asian cultural tendency to avoid categories which may have a degree of stigma (Li et al., 2008). Cultural values associated with East-West cultural differences were also known to influence HFACS classification, with attributions to higher-level conditions driven by investigators’ uncertainty avoidant and longer-term time orientation values (Chan & Li, 2021). Cultural differences similarly influenced attitudes towards safety, with Chinese pilots paying more attention to hierarchy, interpersonal relationships, and hidden power structures, whereas their Western colleagues had a higher level of trust towards organisational Just Culture systems (Liao, 2015). More hierarchical national cultures were also

associated with a stronger preference for automation and set procedures (Sherman et al., 1997).

In addition, professional cultures may also differ between pilots who were initially trained as airline sponsored cadets and their colleagues hired on a contractual basis. Chan & Harris (2019) argued that shared training experiences as schoolmates within the airline's pilot academy can create an 'in-group' identity which has a mitigating impact on Asian pilots' culturally higher power distance. Membership of an in-group can also reduce the propensity to report errors committed by superiors, due to concerns around trust-building and the fear of future negative consequences (Liao, 2015).

C. Research Question

In aviation SMS, the objective within organisations is to identify systemic threats and to create interventions that are compatible with the perceptions of the workforce. Current SMS processes, however, remain "myopic" in the sense that the cultural values of the workforce are viewed as homogenous (Ram, 2022). This creates a challenge for SMS practitioners, especially within multi-cultural airlines, as the workforce can be divided into different groups with different perceptions and training needs. Problems can arise if organisational or professional elements clash with the cultural values of the workforce (Hodgson et al., 2013). When pilots from different backgrounds co-exist in an organisational environment, it becomes important for the organisational SMS to be designed with consideration of these cultural differences.

The goal of this study was to establish whether airline pilots from different national and professional backgrounds differed in their classification of active failures and their latent conditions to different parts of an organisation. The research question was therefore: do experienced Asian pilots from ab-initio cadet backgrounds and Western expatriate pilots attribute safety deficiencies differently, and if so, do these differences vary depending on the type of causal factor involved?

II. METHOD

A. Research Design

An online survey was used for data collection. The survey started with demographic questions to categorise respondents based on their cultural and professional backgrounds. This was followed by an exercise utilising the Human Factors Analysis and Classification System (HFACS). The HFACS is an analytical framework which provides 18 categories of errors, over four organisational levels, in which raters can attribute active failures and their latent conditions. Based on the Swiss Cheese model of accident causation, the HFACS is a systems approach where each of the four levels represent sequential safety barriers within an organization (Wiegmann & Shappell, 2003).

Conditions attributed to the first level of HFACS encompasses active errors and violations committed by frontline operators. Second level categories represent failures arising from substandard conditions and practices. The third level traces the latent conditions up to the supervisory level in an organisation, and the fourth and highest level represents latent faults at higher management levels, such as unsatisfactory resource provision and failures in the organisational climate and processes. Human factors conditions can originate from deficiencies or holes at each level. In theory, an adverse event can be prevented by

correcting a deficiency at any one level in the lead up to the event (Wiegmann & Shappell, 2003; Table 1).

TABLE I. LEVELS OF THE HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM

Level	Category	Examples
L4	Organisational Influences	<ul style="list-style-type: none"> Resource Management Organizational Climate Organizational Process
L3	Unsafe Supervision	<ul style="list-style-type: none"> Inadequate Supervision Planned Inappropriate Operations Failed to Correct a Known Problem Supervisory Violations
L2	Preconditions for Unsafe Acts	<ul style="list-style-type: none"> Adverse Mental States Adverse Physiological States Physical/Mental Limitations Crew Resource Management Personal Readiness Physical Environment Technological Environment
L1	Unsafe Acts of Operators	<ul style="list-style-type: none"> Decision Errors Skill Based Errors Perceptual Errors Violations

The mid-air collision between a Tupolev Tu-154 and a Boeing 757 aircraft over Uberlingen, Germany, on July 1, 2002 (BFU, 2004) was used as the case study for the HFACS exercise. The accident happened at the interface between different cultures (Western/North American vs. Russian Federation crews), professions (pilots and ATC), and involved issues in hierarchical relationships and trust towards organisational systems. For inclusion in the survey, a selection of relevant causal factors from the accident was made based on existing knowledge on East-West cultural differences and professional differences between ab-initio and experienced flight crew (Table 2). These were presented alongside checkboxes corresponding to the HFACS categories. Participants were asked to tick the box corresponding to the category that they wished to attribute as the contributing factor.

TABLE II. SAFETY DEFICIENCIES FROM THE CASE STUDY

Deficiency Type	Case Study Example
Hierarchical relations	"The Tupolev First Officer, who was uncomfortable with the descent, was not forceful enough in communicating his dissatisfaction with the Captain."
Fault within the organisation	"The operations manual to which the Tupolev crew operated under lacked clarity on the relative priority of TCAS and ATC instructions."
Human performance limitations	"There was only one ATC controller on duty, and he had to control two positions simultaneously."
Fault of an external party	"The controller passed incorrect information concerning the position of the Boeing 757 to the Tupolev crew, causing confusion."
Human-machine interface	"Tupolev crew chose to disregard the Traffic Collision Avoidance System (TCAS) directive, and instead followed the instructions issued by the ATC controller."

B. Participants

The participants were recruited through pilot union mailing lists, with participation being voluntary, anonymous, and no identifying information was collected. Ethics approval was provided by the Cranfield University Research Ethics

Committee (12290/2020). The present analysis included responses from N=72 participants who were members of a Hong Kong-based airline pilot union, n=16 of which were pilots of Asian background who were initially trained as airline sponsored ab-initio cadets, and n=56 were civilian trained pilots from Western cultural backgrounds. For the Asian ab-initio group, ages ranged from 25-50 years ($m = 33.5$, $SD = 8.1$) and mean flight experience was 5,303 hours ($SD = 5,699$). For the Western expatriate group, ages ranged from 29-62 years ($m = 43.5$, $SD = 7.6$) and mean flight experience was 11,789 hours ($SD = 6,198$). The participants included Captains ($n=40$), co-pilots ($n=30$), and not reported ($n=2$).

III. RESULTS AND DISCUSSION

A. Hierarchical Relations Between the Organisation and Frontline Operators

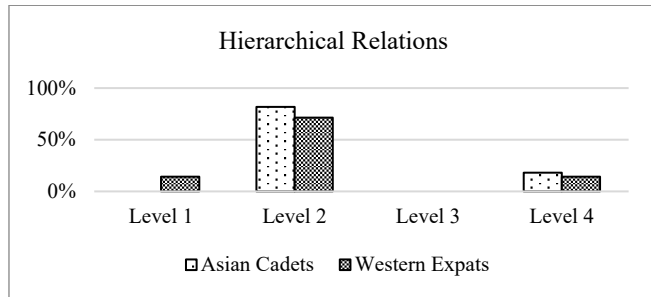


Fig. 1. Percentage of attributions made at each HFACS level for the statement related to deficiencies in hierarchical relations, between pilots of Asian ab-initio and Western expatriate backgrounds..

For the item on the breakdown of hierarchical relations (“First Officer was not forceful enough in communicating his dissatisfaction with the Captain”; Figure 1), attributions to frontline failures (L1) were exclusively made by the Western expatriate group. Asian ab-initio background pilots were comparatively more inclined to attribute the issue to higher level conditions (L2 & L4). The findings reflect different perceptions of hierarchical relationships between the two groups. The propensity of the Western group to attribute hierarchical communication shortcomings to frontline operator-level error suggests that they considered the fault to have originated from individual failures to speak up, whereas the attribution of errors to higher levels by the Asian ab-initio group reflect the established Asian cultural desire to be told what to do (Li et al., 2007).

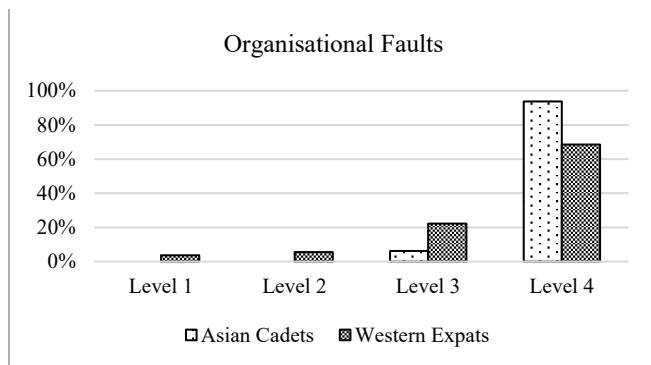


Fig. 2. Percentage of attributions made at each HFACS level for the statement related to organisational faults, between pilots of Asian ab-initio and Western expatriate backgrounds.

Similar differences between Asian ab-initio and Western expatriate pilot groups can be identified in the results on the organisational shortcomings item (“the operations manual lacked clarity”). Figure 2 presents a clear pattern where the Asian ab-initio group only attributed this shortcoming to conditions at the supervisory and organisational tiers (L3 & L4). This differed to the Western group, which also made attributions to lower levels (L1 & L2). This may be reflective of the Asian cultural desire to maintain harmony among people, and the Asian ab-initio pilots’ identity as members of the organisational or collective ‘in-group’ (Chan & Harris, 2019; Liao, 2015). Rather than attributing errors to individual operators, the preference for Asian ab-initio pilots may be to resolve the deeper latent conditions held within the organisation to which they are loyal to.

A similar pattern was found in the perception of human performance limitations. On the item reflecting mental overload (“one ATC controller had to control two positions simultaneously”; Figure 3), the Asian ab-initio group made attributions exclusively at level 2 and above, whereas their Western expatriate colleagues considered the mental overload condition to have also originated from frontline operator faults at level 1. This confirms the Asian cultural tendency to avoid categories with a degree of stigma and to maintain in-group harmony (Li et al., 2008). Additionally, this finding also reflects cultural differences in world view. Participants from the collectivistic Asian culture considered the human performance limitation to have originated from wider contextual issues, whereas the participants from individualistic, Western backgrounds were inclined to focus on the actions of individual frontline operators.

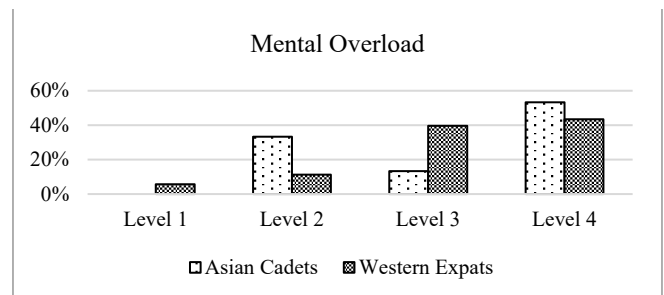


Fig. 3. Percentage of attributions made at each HFACS level for the statement related to human performance limitations, between pilots of Asian ab-initio and Western expatriate backgrounds.

For SMS functions, it can therefore be deduced that interventions at the frontline will be considered more relevant and acceptable for the Western expatriate group, and Asian ab-initio pilots will have greater preference for supervisory or administrative interventions to correct for interpersonal dynamics and factors affecting human performance.

B. External Faults

Whilst organisational shortcomings were predominantly attributed to higher-level conditions by the Asian ab-initio group and to lower-level failures by the Western expatriate pilots, a converse pattern was found when the faults originated from external parties (“the controller passed incorrect information”). Figure 4 presents a pattern where the Asian ab-initio group focused their attributions to lower operator and preconditions levels (L1 & L2), and the Western expatriate group made comparatively more attributions to the preconditions and supervisory levels (L2 & L3).

Since the shortcomings in this example originated from ATC operators and was therefore external to the pilots' airline or the immediate social group, it is reasonable to believe that the Asian ab-initio group was less inhibited in attributing faults to operator errors at level 1. On the other hand, the Western expatriates' comparatively greater focus on preconditions and supervisory faults (L2 & L3) suggests that their perspective was less retributive towards errors of individual operators. As the Western culture was associated with a higher level of trust towards Just Culture systems (Liao, 2015), the finding of the less retributive approach was not surprising.

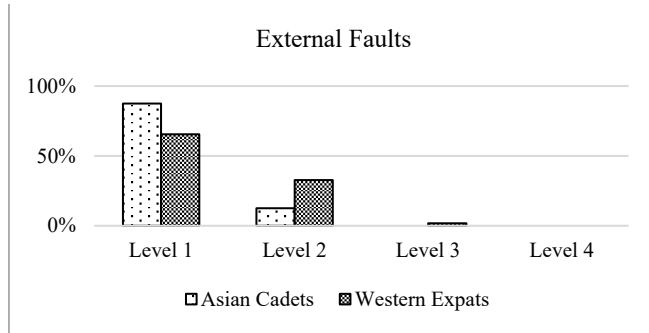


Fig. 4. Percentage of attributions made at each HFACS level for the statement related to external faults, between pilots of Asian ab-initio and Western expatriate backgrounds.

C. Human-Machine Interactions

Differences in the attribution of latent conditions was also identified in the item related to resolving conflicts between human commands and machine guidance ("Tupolev crew chose to disregard TCAS and followed ATC instructions"). As presented in Figure 5, attributions to preconditions for unsafe acts (L2) was exclusively made by the Western expatriate group. A comparatively larger proportion of the Asian ab-initio group considered the shortcoming to have originated from latent factors from the frontline and supervisory levels (L1 & L3).

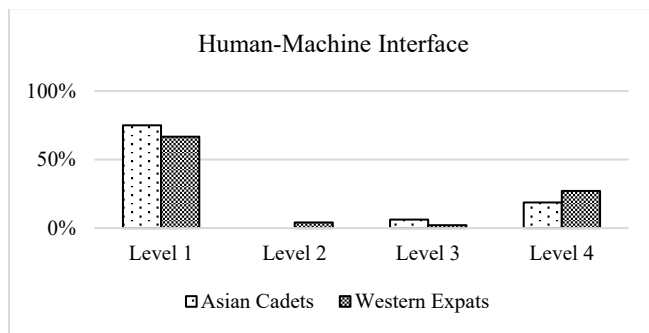


Fig. 5. Percentage of attributions made at each HFACS level for the statement related to conflicts in the human-machine interface, between pilots of Asian ab-initio and Western expatriate backgrounds.

A closer look into the elements within the HFACS levels 2 and 3 provides an explanation for this finding. Preconditions for unsafe acts at HFACS level 2 consists of elements such as faults in the technological design, adverse mental, physiological, and physical conditions related to the operation of (e.g., TCAS) equipment, or human factors influencing operational conditions and decision making (Wiegmann & Shappell, 2003). Therefore, the Western expatriates' attributions to level 2 likely suggests that they considered the Tupolev's crew election to disregard TCAS and follow ATC

commands to have resulted from conditions in the human-machine interactive interface.

In contrast, unsafe supervision at HFACS level 3 includes elements such as supervisory inadequacies in providing training and guidance, poor operational planning (e.g., excessive tasking), failure to correct known problems, and supervisory violations (e.g., inadequate documentation) (Wiegmann & Shappell, 2003). These factors are reflective of latent conditions originating from the decision makers within an organisation. Firstly, as it was known that pilots from more hierarchical cultures had a stronger preference for following established procedures (Sherman et al., 1997), it was perhaps unsurprising that the Asian group in this study focused on deficiencies in training and guidance. Secondly, together with their more frequent use of the frontline operator categories at level 1, it can be surmised the Asian ab-initio group considered the same causal factor to have originated from wider inadequacies across the organization.

D. Cultural Consequences for Safety Management

The findings demonstrate the importance of understanding cultural differences between employee groups when managing SMS within organisations. If only certain groups within the workforce are responsible for running the SMS, then the safety conditions will be perceived through a myopic cultural lens. The SMS objectives, risk management goals, and subsequent interventions may be constructed in a way that is not congruent to the perception and desires of other cultural groups.

To illustrate, consider the attribution of latent conditions related to hierarchical relations (Figure 1) and organisational faults (Figure 2). If a Western expatriate pilot was tasked with the safety management role, then according to the present findings, it is likely that they will set the SMS objective to encourage pilots to speak up. Based on this objective they may come up with SMS interventions through frontline crew training. However, this is incongruent with the perspective of Asian ab-initio pilots. As opposed to an issue with speaking up, the Asian group would probably consider the issue to be related to the provision of guidance by management and social needs to maintain group harmony. These factors require correspondingly high-level organisational changes or alterations to the sociological culture external to the organisation. Unless the original attribution of conditions can be evaluated with a culturally inclusive perspective, then these intervention methods may be missed, and the interventions carried out may be poorly received by certain groups within the workforce.

In a sense, this problem is similar to that historically encountered when Crew Resource Management training was exported unchanged from the U.S. to other countries in the 1980's, when concepts such as assertion baffled professional pilots of Asian backgrounds (mainly in Korea & Taiwan) (Helmreich & Merritt, 1998). As the workforces within large airlines become increasingly diverse in the future, it will be beneficial for safety managers within these organizations to ensure that a wider range of perspectives are included in the SMS.

E. Limitations and Further Research

Although the two groups were similarly qualified in terms of licensing, operational proficiency, and organizational environment, a limitation of the present research is that the age and total flight experience (measured in hours) between the

Asian ab-initio and Western expatriate groups were not equivalent. Whilst it was previously established that total flight hours had no impact on pilots' threat detection, management, and response (Todd & Thomas, 2012), it is nevertheless possible that age and total flight hours could influence the perception of other safety issues. This presents the opportunity to conduct further research on the effects of age and experience as confounding variables. For example, future studies using repeated measures designs may be desirable to evaluate changes as pilots acquire greater levels of experience or operational exposure.

IV. CONCLUSION

As the demand for pilots in China and the Asia region exceeds domestic supply, both airline sponsored ab-initio cadet schemes and foreign expatriates hired on contract are becoming more prevalent. Whilst the two groups can often be found working together in the same organization, there is little research on how national and professional cultural differences between the two groups can lead to conflicts in the development of organizational SMS objectives and interventions. In the present research, airline pilots' initial training backgrounds were compared to their classification of human factors shortcomings related to hierarchical relations, organizational faults, human performance limitations, external faults, and human-machine interface conflicts. It was discovered that Asian cultural desires to maintain interpersonal harmony and for top-down guidance affected their perception of deficiencies related to hierarchical relations, organisational faults, and human performance limitations, making a proportionately greater number of attributions to latent conditions at higher organisational levels. The desire for top-down guidance was replicated in the attribution of conflicts in the human-machine interface. The converse was found for deficiencies related to external faults, where the social distance made the Asian group less inhibited in attributing failures to the individual operator. On the other hand, Western expatriate pilots considered deficiencies due to hierarchical relations to be caused by lower-level operators' failure to speak up, and conflicts in the human-machine interface were attributed to technological, physical, and operator conditions. It is suggested that these cultural differences in the interpretation of events should be taken into account when managing SMS functions to ensure that objectives and interventions will remain congruent to the perceptive characteristics of the target workforce.

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2023-09-15

Institute of Electrical and Electronics Engineers (IEEE)

<https://doi.org/10.1109/ICTIS60134.2023.10243970>

Chan W, Li W-C. (2023) Perception of causal factors in flight operations between ab-initio and expatriate pilots. In: 2023 7th International Conference on Transportation Information and Safety (ICTIS), 4-6 August 2023, Xi'an, China, pp. 1728-1732