The Differences of Aviation Human Factors between Individualism and Collectivism Culture

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Abstract. Culture is at the root of action; it underlies the manner by which people communicate and develop attitudes towards life. This research examined statistical differences in the 18 categories of Human factors Analysis and Classification System (HFACS, Shappell & Wiegmann, 2003) across 523 aviation accidents in the Republic of China (a collective culture) and 119 aviation accidents in the USA (an individual culture) . The result suggests that the culture of individualism seems to be superior for promoting aviation safety compared to collectivist cultures, however, factors such as the design of the aircraft, the management procedures and the nature of safety regulation all have a strong Western influence from the individualist culture. All of these factors are culturally congruent with the USA. It is essential to identify the potential causal roots for these differences from the underlying factors in these aviation mishaps, and identify what kind of factors drive people to act or react to dynamic situations that either lead to an accident help to develop an effective accident prevention strategy.

Keywords: Accident Investigation, Aviation Safety, Cross-culture, Human Factors.

1 Introduction

It is generally acknowledged that the accident rates differ in different regions of the world, Asia and Africa are higher than Europe and America. The regional differences in accident rates suggest that there might be something further beneath simply human error in aviation operations [6]. In order to survive, aircraft operators attempt to maximize the benefits and minimize the risks. If most of the people in a society have the same way of doing things, it becomes the content of the culture. Culture is the means by which people communicate and develop their knowledge about attitudes towards life. Culture is the fabric of meaning in terms of which human beings interpret their experience and guide their actions [4].

There are fundamental difference between Chinese minds and Western. In science and technology, Western Truth stimulated analytic thinking, whereas Eastern Virtue led to synthetic thinking. Through their different logics East and West followed

different paths in developing government and in developing science and technology. Whereas the Romans spread the principle of 'government by law', the main continuous principle of Chinese was 'government by man' [3, 4]. Soeters and Boer [13] found that more individualist cultures showed a lower probability of total loss accidents. On the other hand, collectivist cultures exhibited a greater chance of accidents. As aircraft have become increasingly more reliable, human performance has played a proportionately increasing role in the causation of accidents.

In recent years, in accident investigation the scientific focus has shifted away from psychomotor skill deficiencies and emphasis is now more placed upon inadequacies in decision-making, attitude, supervisory factors and organizational culture as being the primary causal factors [1, 5, 8]. Based upon Reason's model [12] of human error in which active failures are associated with the performance of front-line operators in complex systems and latent failures are characterized as inadequacies or mis-specifications which might lie dormant within a system for a long time and are only triggered when combined with other factors to breach the system's defenses, the Human Factors Analysis and Classification System (HFACS) was developed as an analytical framework for the investigation of the role of human factors in aviation accidents. The HFACS was originally designed and developed as a generic human error framework for investigating and analyzing human error accidents in US military aviation operations. HFACS has been shown to be useful within the context for civil and military aviation, as both an effective data analysis framework and a reliable accident investigation tool for over twenty years [16].

Recently, research comparing the underlying patterns of causal factors in accidents comparing Eastern and Western cultures has suggested underlying differences attributable to culture. Using the Human Factors Analysis and Classification System, it was observed that issues concerning inadequate supervision at higher managerial levels and sub-optimal organizational process were more likely to be implicated in accidents involving aircraft from Eastern cultures [11]. It was suggested that small power-distance cultures with a high degree of individualism seemed to be superior to collective with high power-distance cultures for promoting aviation safety, especially in terms of the processes and procedures at the higher organizational levels. Such an analysis may provide additional explanatory power to elucidate why national differences in accident rates occur, however, it provides no explanatory power to explain why individualist cultures were safer than collective cultures in the aviation industry.

The power of culture often goes unrecognized since it represents 'the way we do things here'. There have been several studies investigating the relationship between culture and accident causal patterns [2, 7, 13]. However, no research has investigated specifically the relationship between collectivist cultures and individualist cultures to the underlying causes of accidents. There is an increasing need for investigating the relationship between Chinese culture and safety of aviation operations for the both of Chinese population and the South Eastern Asian market for aviation industry.

2   Method

Data: There were 523 accidents with 1,762 instances of human error categorized using the HFACS framework from data collected by the Taiwan Air Force between 1978 and

2002 [10]; and 119 accidents with 319 of categorized instanced of human error in US data recorded between 1990 and 1996 [15]. According to Hofstede's [4] cultural dimension of Individualism versus Collectivism, the score of Taiwan is 17, the score of US is 91; the world average is 43. It is clear that Taiwan is a collective culture, the US is an individualist culture. It is hypothesized that these different cultures will show different patterns in the underlying causal factors in aircraft accidents.

Classification Framework: This study based on the HFACS framework as described in Wiegmann & Shappell [14 - 16]. The first level of HFACS categorizes is 'unsafe acts of operators' that can lead to an accident including four sub-categories of 'decision errors'; 'skill-based errors'; 'perceptual errors' and 'violations' . The second level of HFACS concerns 'preconditions for unsafe acts' which has a further seven sub-categories of 'adverse mental states'; 'adverse physiological states'; 'physical/mental limitations'; 'crew resource management'; 'personal readiness'; 'physical environment', and 'technological environment'. The third level of HFACS is 'unsafe supervision' including 'inadequate supervision'; 'planned inappropriate operation'; 'failure to correct known problem', and 'supervisory violation'. The fourth and highest level of HFACS is 'organizational influences' and comprises of the sub-categories of 'resource management'; 'organizational climate' and 'organizational process'.

To avoid over-representation from any single accident, each HFACS category was counted a maximum of only once per accident. These counts acted simply as an indicator of presence or absence of each of the 18 categories in any given accident. These data were then subject to chi-square ($\chi 2$) analyses to measure the statistical strength of association between HFACS category and country.

Reliability of HFACS Framework: Inter-rater reliabilities for the data from Taiwan, calculated as a simple percentage rate of agreement, the reliability figures for the 18 categories of HFACS between 72.3% and 96.4% [10]. The average of the inter-rater reliabilities of the data gathered from the US data was 76% [15].

3   Results and Discussion

There were six HFACS categories that exhibited significant differences in the frequency of underlying causes in aviation accidents between Taiwan and US (Table 1). The category of 'resource management' ($\chi 2= 50.09$, df=1, p=.000) at level-4 was over-represented in Taiwan and was under-represented in the USA. The category of 'inadequate supervision' ($\chi 2= 39.45$, df=1, p=.000) at level-3 was over-represented in the Taiwan sample and under-represented in the USA.

There were two categories with significant differences in frequency of occurrence between Taiwan and the USA at level-2: 'personal readiness' ($\chi 2= 6.91$, df=1, p=.008) was over-represented in Taiwan, and under-represented in US accidents; 'adverse mental states' ($\chi 2= 21.35$, df=1, p=.000) was over-represented in the Taiwan, and under-represented in the USA sample; Finally, there were two HFACS categories which showed differences in the frequency of occurrence between the two regions at level-1: 'decision errors' ($\chi 2= 7.99$, df=1, p=.004) was over-represented in Taiwanese sample and under-represented in the US sample; and 'skilled-based errors' ($\chi 2= 11.65$, df=1, p=.000) were over-represent in US accidents but under-represented in the sample from Taiwan.

Table 1. The Frequency of HFACS Categories in Taiwan and USA

HFACS Categories	Taiwan		USA	
	Yes	No	Yes	No
Organizational process	76	447	10	109
	80	443	18	100
Organizational climate	4	519	0	119
	7	516	2	117
Resource management	184	339	3	116
	156	366	36	83
Supervisory violation	8	515	2	117
	9	514	2	117
Failed correct a known problem	12	511	2	117
	12	511	3	116
Planned inadequate operations	24	499	1	118
	22	501	5	114
Inadequate supervision	177	346	6	113
	144	379	33	86
Technology environment	44	479	na	na
	na	na	na	na
Physical environment	74	449	na	na
	na	na	na	na
Personal readiness	29	494	0	119
	25	498	6	113
Crew resource management	146	377	35	84
	142	381	32	87
Physical/mental limitation	73	450	13	106
	77	446	17	102
Adverse physiological states	2	521	2	117
	5	518	1	118
Adverse mental states	184	339	16	103
	156	367	36	83
Violations	160	363	32	87
	158	365	36	83
Perceptual errors	116	407	17	102
	106	417	24	95
Skilled-based errors	226	297	72	47
	245	278	56	63
Decision errors	223	300	34	85
	202	321	46	73

Hofstede [4] defined the dimension of Individualism (IDV) as:

'A High Individualism ranking indicates that individuality and individual rights are paramount within the society. Individuals in these societies may tend to form a larger number of looser relationships. A Low Individualism ranking typifies societies of a more collectivist nature with close ties between individuals. These cultures reinforce extended families and collectives where everyone takes responsibility for fellow members of their group'.

There are fundamental difference between Chinese minds and Western minds. Through their different logics, the main continuous principle of the Chinese was 'government by man', focusing on the inter-relationship in the environment, which resulted in very different ways of making inferences about the world. Westerners followed different paths in developing science and technology. American emphasis on identity is based in the individual and the same rules should apply to everyone as justice should be blind.

The category of 'Resource management' (level-4) includes the selection, staffing and training of human resources at an organizational level, excessive cost cutting, providing unsuitable equipment, and a failure to remedy design flaws. It is clear for over-represented in Taiwan and under-represented in US, as Chinese society is relationship-orientation which means people need to have a connection with the person in charge for getting the necessary resources easily. Resources were managed more unevenly (or unfairly) in a collectivist culture than individualist culture. As a result, collectivist cultures exhibit a greater likelihood of accidents than individualist culture [13].

The category of 'inadequate supervision' (level-3) includes factors such as a failure to provide proper training, a lack of accountability, failure to track qualifications and performance, using untrained supervisors and loss of situation awareness at the supervisory level. It was over-represented in the Taiwanese sample and under-represented in the US sample. In the Chinese culture emphasis is on 'government by man' and 'harmony priority' to keep face for each other. As a result, the principles and regulations for flight operations were applied flexibly. This can also be supported from the frequency of violation of SOPs. There is a famous Chinese saying 'open one eye, close the other eye' for different regulations applying to different people with different relationships. Western culture believes in absolute guidelines about right and wrong, Chinese culture believes what is right and wrong depends on the circumstances. This may be illustrated from the US data which has a lower accident rate in the category of 'inadequate supervision' than Taiwan. The supervisory levels in Taiwan were not following strict principles when performing their duties which caused problems.

There were two categories with significant differences between Taiwan and the US at 'Preconditions for unsafe act' (level-2). Both were over-represented in their frequency of occurrence in Taiwan, and under-represented in US accidents. 'Adverse mental states', which includes issues such as stress, loss of situational awareness, distraction and task saturation; and 'Personal readiness' which encompassed issues associated with inadequate training, self-medication, poor diet, and overexertion while off duty. In patterns of attention and perception, Chinese attend more to the whole

environment: Americans attending more to individual objects. Westerners prefer the use of formal logical rules to understand events. As a result, Westerners more precisely identify the problems in front of them than Easterners do.

There were two categories with significant differences between Taiwan and US at the level of 'Unsafe act of operators' (level-1). The category of 'Decision errors', which includes issues such as selecting inappropriate strategies to perform a mission; improper in-flight planning; making an inappropriate decision to abort a take-off or landing; or using improper remedial actions in an emergency, was over-represented in the Taiwanese sample and under-represented in the US sample. In the development of science and technology, American culture stimulates analytic thinking, whereas Chinese is inclined to synthetic thinking [4]. This cultural characteristic is illustrated by the Chinese having a higher instance of 'decision errors' than the US sample, perhaps because the cockpit designs are based upon a Western approach. It is not necessary true that the analytic thinking approach is a safer approach than the synthetic thinking in aviation domain. However, there was only one category over-represented in US accidents but under-represented in the sample from Taiwan, that was 'Skill-based errors', which includes actions such as inappropriate stick and rudder coordination; excessive use of flight controls; glide path not maintained, and adopting an improper airspeed or altitude. It may be suggested that the explanation for these observations is that the US has a culture which prefers individual decision making and responsibility for the self, they believe more in the controllability of situation than Chinese. In Hofstede's [4] terms the USA is an ego-oriented society.

The difference between individualist and collectivist cultures was found to be based on the ways of communication. High-context communication fits the collectivist society, and low-context communication is more typical for individualist cultures [4]. High-context communication implies that little has to be said because most of the information is either in the physical environment or internalized in the person. On the other hand, low-context communication implies that the mass of information is made explicit. The US culture has strong desire searching for truth and governed by 'law', the regulations are clearly specific to follow. The Chinese tradition does not hold laws and abstract principles in high regard and is governed by 'man', only a small part is in the coded. This could possibly explain the Taiwanese higher accident rate involving 'resource management' (level-4) as Chinese culture is relationship orientated. Value standards differ for in-groups and out-groups. Furthermore, Western culture believes in absolute guidelines about good and evil, Chinese culture believes what is good and evil depends upon the circumstances. It might be illustrated from the US data which has a lower accident rate in the category of 'inadequate supervision' (level-3) than the Taiwanese sample. The supervisory levels in Taiwan were not following strict principles to perform their duties which caused problems. The cultural difference which dictates that 'ability most important for career of Westerners' with 'employees responsible for themselves' might explain the lower US rate of 'adverse mental states' (level-2) being involved in accidents than in the Taiwanese sample. Also, the 'knowing the right person most important for career' in collectivist cultures underlay the precondition for unsafe acts and caused a higher 'personal readiness' problem (level-2) in Taiwan than in the US.

4   Conclusions

People from different nations differ in their cognition in ways that result in dissimilar perceptions, judgments and decision-making [9]. National culture provides a fundamental basis for a group member's behavior, social roles and cognitive processes. It also provides underlying rules about safety, effective communication, and provides the basis for verbal and nonverbal interactions. This research, using the HFACS framework suggests that there are six categories having significant differences in the relative frequencies of the underlying human factors causes in aviation mishaps between Taiwan and US. The underlying cultural causes of these differences are postulated. It should be noted, the individualist culture seems to be superior for promoting aviation safety compared to the collectivist cultures. However, factors such as the design of the aircraft, the management procedures and the nature of safety regulation all have a strong Western influence from an individualist culture. All of these factors are culturally congruent with the USA. It is essential to identify the potential causal roots for these differences in relative frequency of the underlying factors in these aviation mishaps, and identify what kind of factors drive people to act or react in the dynamic situations that lead to an accident to develop effective accident prevention strategies

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