



Perception of safety culture: Surveying the aviation divisions of Ministry of National Defense, Taiwan, Republic of China

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ABSTRACT

The Aviation Divisions of the Ministry of National Defense (ADMND), Taiwan, Republic of China (ROC) have established internal independent safety audit systems across various divisions to improve aviation safety performance and maintain safety records. The safety audit systems include a pilot reporting system, operation risk management, operation information resource management, flight and base service reporting system, etc. that are similar to the key elements of Safety Management Systems (SMS). SMS shapes the local culture and is thus, a safe operational environment. As the safety culture is one of the critical deliverables of SMS implementation, this study examined the architecture of the relationships between components of organizational safety culture, including informed, reporting, just and learning/adaptive subcultures—all embedded within the ADMND in Taiwan. A total of 915 valid questionnaires, collected from crewmembers (pilots and ground support staff) of ADMND, were analyzed and formed the basis for structural equation modeling and subsequent analyses. The analytical results indicated that safety culture has been well-established within the ADMND which is fully in compliance with the fundamental implementation of SMS (AC 120-32C) issued by the Civil Aviation Administration of the Ministry of Transportation, Taiwan, ROC.

1. Introduction

The Wright Brother's first successful heavier-than-air manned flight on December 7, 1903 was simply a 12-s short journey with flying distance of 120 feet at a windy town named Kitty Hawk, North Carolina, USA. The Wright Brothers' remarkable milestone has initiated the journey of human flight and related research. After a century of progress, flying faster and staying longer in the air has been far beyond just a dream. However, along with the development of aircraft technology, safety programs are equally important, which help control and reduce potential hazards in relation to human operations. For instance, in the 1990s, understanding human factors associated with unsafe behaviors resulted in the improvement of human-machine interface design. Meanwhile, for effective safety training, Crew Resource Management (CRM), was introduced to the industry to avoid or mitigate risks due to human errors (Helmreich et al., 1999; Helmreich, 2000). In Taiwan, CRM has evolved to a new level, namely Corporation Resource Management (Tsuei and Wang, 2014) that involves all segments of an organization. Moreover, Taiwan's aviation organizations are also requested by the government to implement various safety programs such as quality management system (QMS), environment management system (EMS), occupational health and safety management

system (OHSMS), and security management system (SeMS)—to achieve the safety goals (Civil Aviation Administration, 2011). The Civil Aviation Administration (CAA) of Taiwan closely follows the standards imposed by the International Civil Aviation Organization (ICAO) including the ICAO Doc. 9859 Safety Management Manual. In order to integrate safety programs, the ICAO has enclosed SMS into Annex 6, 11, and 14 in 2006 aiming to create a safer aviation environment (ICAO, 2006; ICAO, 2009). ICAO requests that the Operation of Aircraft (Annex 6), Air Traffic Services (Annex 11), and Aerodrome (Annex 14) should implement SMS before 2011/1/1. The CAA of the Ministry of Transportation (MoT), Taiwan, Republic of China (ROC) also issues Advisory Circular 120-32C "Safety Management System—SMS" in 2011, in order to help aviation organizations plan and implement SMS (CAA, 2011). CAA AC-120-32C, adopts ICAO 9859; FAA AC 120-92A and AC 150/5200-37 and provides a specific guideline of SMS concepts, policies and process. (FAA, 2006, 2007, 2008, 2010) The CAA AC 120-32C highlights acceptable means to comply with ICAO Article 9 of "Aircraft Flight Operation Regulations" or Article 27 of "Regulations for Repair Station Certification and Management" for establishing and implementing a safety management system (CAA, 2011). Per CAA AC 120-32C, SMS implementation must include the following four (4) components and twelve elements:

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1. Safety Policy and Objectives,
 - Management commitment and responsibility,
 - Safety accountabilities,
 - Appointment of key safety personnel,
 - Coordination of emergency response planning,
 - SMS documentation.
2. Safety Risk Management,
 - Hazard Identification,
 - Safety risk assessment and mitigation.
3. Safety Assurance,
 - Safety performance monitoring and measurement,
 - The management of change,
 - Continuous improvement of the SMS.
4. Safety Promotion,
 - Training and education,
 - Safety Communication. (CAA, 2011)

Besides ICAO and CAA of Taiwan, the common SMS components have been implemented by the major aviation organizations and authorities worldwide including the United Kingdom Civil Aviation Authority (UKCAA), Transport Canada (TC), U.S. Federal Aviation Administration (FAA), and Australia Civil Aviation Safety Authority (CASA) (UKCAA, 2002; TC, 2002; CASA, 2005; FAA, 2006, 2007, 2008; ICAO, 2009; CAA, 2011). However, numerous researchers have pointed out that the core value behind a successful, well-executed safety management in an organization is its safety culture and self-improving safety assurance (Reason, 1998; Cheyne et al., 1998; Helmreich et al., 1999; Cooper, 2000; Glendon and Stanton, 2000; Guldenmund, 2000; Lee et al., 2006; Gibbons et al., 2006; Bos and Lu, 2007; Ek and Akselsson, 2007; Fernández-Muñoz et al., 2007; Kao et al., 2009; JPDO, 2010; Schreckengast and Lu, 2010; O'Connor et al., 2011; Wang and Lui, 2012; Fu and Chan, 2014). The safety culture includes two concepts where safety is a status of an organization free from potential hazards and culture is the behavioral norm (Schreckengast and Lu, 2010). Therefore, the formation of a safety culture should be a role-modeling process that consists of belief, attitude and recognition of the core-value of safety commonly shared by members of the organization (Reason, 1998; Cox and Flin, 1998; Pidgeon, 1998). When such a role model is emulated and behaves as a norm, a successful SMS implementation is therefore featured within an organization. CAA Taiwan, although not a member of ICAO, has requested Taiwanese civil aviation organizations to implement SMS by 2012. Clearly, ADMND and its military sub-divisions have no obligation to implement SMS since ADMND operates independent aviation safety systems supervising special military mission requirements associated with unique aircraft weapon systems and manpower capabilities. Thus, a different approach of SMS implementation between military organization and civil aviation industry obviously calls attention to ADMND safety concerns. That is because the safety culture of the civil aviation industry deliberately separates aircraft from risks; yet, the daily mission of military aircraft is to engage an enemy thereby forming a 'culture of war' (Wilson, 2008, p. 14). For instance, the Air Force (AF) jetfighter pilots are guided under the instructions from the Tactic Air Traffic Command Center to approach any invading aero-vehicles. In the engaging stage, the pilot has to proactively make a quick decision to dodge any hostile lock-on, and take counterpart action to attack the invader. At such high-speed maneuvers, the price for the slightest mistake is either aircraft loss or fatal accident. Therefore, each AF pilot is an independent warrior in the sky, and the survivability depends on his/her own decision-making process. On the other hand, the aviation division of the Army is classified as a power supporting force in which the helicopter pilots are guided into an airfield to execute missions such as searching targets or providing ground fire supports. Such missions, usually operating at low-altitude airspace, will definitely not only put pilots into an enemy's firing range, but militate agile maneuvering among terrain hazards (hills, treetops, high voltage towers) or unexpected environmental

hazards (clouds, gusts, haze, rains, or darknight). Low-speed maneuvers buy more time for quality decisions against such hazard; however, the surrounding terrains and unexpected environmental changes are lethal threats to the safety of helicopter pilots. Doubtless, full compliance with standard operation procedures (SOPs) and well-scheduled pre-flight plans can really save helicopter pilots' lives. The aforementioned tactic missions are typical military daily training operations of the Air Force and Army. Clearly, different military actions lead to different safety cultures that functioned under different operational philosophies. A retired Lieutenant Colonel James Smith states that: '.....(AF) Culture is a patterned way of thinking focused on the organization's central tasks (operations) and relationship (administration) passed on by generations and is slow to change' (Smith, 1998, p.41). Three subcultures of Air Force safety culture, according to Smith's comments, can be defined as: a mission-oriented culture, a rank-ordering elite culture, and a slow-changing culture. Particularly mentioned in Smith's study, the slow-changing culture, in contrast to a flexible culture, is only 'in response to internal pressures to adapt to a changed operational environment, not in response to external direction' (Smith, 1998, p. 42). Therefore, a potential culture conflict is possible between military (risk-taking culture) and civil aviation industry (risk-avoiding culture) when an identical SMS program is implemented. A rank-ordering elite culture contributes partially to the formation of a slow-changing culture since the transformation is required from the senior leadership at the top of the corps elite (Smith, 1998). While the ADMND has implemented SMS to all military units, there is a need to understand how military officers perceive the value of SMS. Should SMS components be modified for the military world? What is (are) the alternative(s) component(s) of a military-oriented SMS? In all, the question that must be answered first is: "What is the current safety culture of ADMND, Taiwan, ROC after the implementation of CAA SMS?" Particularly, what is the perception of the crew members regarding the current safety culture?" Through a systematic survey on pilots, and ground support staff (GSS, including maintenance crews, air traffic controllers, weather forecasting wing, and logistical units etc.) of ADMND, a safety culture gap analysis was conducted.

2. Literature reviews of safety culture

The SMS is a systematic safety program embracing all the safety measures and procedures (Gill and Shergill, 2004; Lu et al., 2007; JPDO, 2010; CAA, 2011; Remawi et al., 2011; Fu and Chan, 2014; Wilke et al., 2014). The core value and the decisive evident to judge a successful SMS implementation is an organization's safety culture (Reason, 1998; Helmreich et al., 1999; Cooper, 2000; Lee et al., 2006; Bos and Lu, 2007; Ek and Akselsson, 2007; Fernández-Muñoz et al., 2007; Kao et al., 2009; Schreckengast and Lu, 2010; Wang and Lui, 2012). Safety culture has been widely discussed in aviation society in the past two decades as human errors continuously become one of the root causes taking part in many accidents, incidents or near-miss events. A safe aviation operation depends, not only on leading-edge technology (superior structure and reliable engine design, robust avionic instruments and precise navigation systems) or strict aviation regulations, but also on the understanding of decision-making processes based on human behavior. Crew Resource Management has advanced into the 5th generation, the so-called Error Management (EM; Helmreich et al., 1999) and the 6th generation- the Threat/Error Management (TEM, Helmreich, 2000) since the beginning of this century. The purpose of CRM training is to allocate adequate resources efficiently to cope with or avoid human errors. CRM education also provides detecting tools to effectively predict potential threats that could lead to human errors. Helmreich states that: "CRM can use to manage error; and... safety requires focusing each of these toward an organizational 'safety culture' that deals with errors nonpunitively and proactively (Helmreich et al., 1999, p. 30). Generally speaking, a safety culture of an organization is composed of two essentials: important

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