

**Safety Performance Comparisons in
Scheduled U.S. Carrier Operations: 2000-2004**

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ABSTRACT

Airline safety is an important factor that customers seek and expect from air carriers. Safety performance, related to the rate of accidents and incidents, is frequently associated with the effectiveness of a carrier's internal processes. On-time performance, lost luggage, and customer complaints are, among others, publicly reported performance indicators that may differentiate one carrier from another. This article will consider how safety as a key performance indicator may reflect the effectiveness of the organization's operational policies and processes. The paper proposes that low-cost carriers (LCCs) demonstrate a better safety performance record than mainline and regional carriers. The results of this exploratory study of five years of safety and on-time performance data involving carriers in the United States suggest that the low-cost carrier segment is less prone to accidents and incidents and offers the best performance. As a result, the low-cost business model may improve an airline's safety and operational performance since it more efficiently transforms organizational inputs into safety performance outcomes. A model explaining the relationship between key characteristics of low-cost carriers and a higher performance standard is presented.

INTRODUCTION

The findings of this study appear to be inconsistent with public perception in many countries, which has been conditioned by the idea that as low-cost carriers focus on the "bottom line" to lower costs, these reductions may impact internal processes, such as safety, in a negative manner. Recent low-cost airline accidents, for example the total loss of a Helios Airways B737 on 14 August 2005, have resulted in renewed speculation about the safety performance of low-cost carriers. It is important to note, however, that not all carriers offering low fares follow the LCC business model, as will be explained later. Moreover, simply because they label themselves as low cost does not necessarily mean that they are indeed successful low-cost operators.

Several civil aviation authorities around the world publish information on "blacklisted" operators.ⁱⁱ Some of these operators are LCCs.

Furthermore, Directors General of Civil Aviation from Contracting States of the International Civil Aviation Organization (ICAO) meeting in Montreal, Canada, (20-22 March 2006) agreed to post results from the Organization's Universal Safety Oversight Audit Program (USOAP) on the ICAO public website.ⁱⁱⁱ At the conclusion of the conference, 70 States authorized ICAO to publish the information. Summary safety reports that will be published on the ICAO website will cover eight areas: a. aviation legislation; b. operating regulations; c. structure of the civil aviation administration and safety oversight function; d. technical guidance material; e. technical personnel; f. licensing and certification obligations; g. continuing surveillance obligations; and h. resolution of safety issues. States will be able to add complementary data to help evaluate the level of safety in their country.

ⁱⁱ See: the French Civil Aviation Authority's (Direction Generale de l' Aviation Civile) website (<http://www.dgac.fr>), as an example. The French Civil Aviation Authority was one of the first

regulators around the world to publish a list of "blacklisted" airlines.

ⁱⁱⁱ See: ICAO News Release (PIO 04/06). Directors General of Civil Aviation Agree on Greater Transparency and Sharing of Information. Montreal, Canada, 22 March 2006.

From the launch of the Program in January 1999 to the end of 2004, 181 Contracting States were audited and 163 received follow-up audits based on State action plans to correct deficiencies.

In addition, the International Civil Aviation Organization together with the International Air Transport Association (IATA) have agreed to share safety-related information from their respective audit programs in their effort to better identify potential safety risks and prevent air carrier accidents. Under a Memorandum of Cooperation, each organization will provide the other with information from safety oversight audit results, as well as accident and incident monitoring. Also, experts from each organization will be allowed to participate as observers in audit missions of the other.^{iv}

The IATA Operational Safety Audit (IOSA) program was the first global standard for airline safety management. Since its inception in 2003, over 150 airlines representing 70% of international scheduled traffic have been IOSA audited and there are close to 100 airlines in their Registry. The IOSA Registry is publicly accessible on the IATA website. It complements ICAO's USOAP, is recognized by many governments, and will be a condition for membership in IATA by the end of 2007.

In an effort to understand better how and why the above mentioned public perception about LCCs and safety may or may not be valid, let us examine what safety is and how it is linked to organizational effectiveness in the case of air carriers. Safety is a very important factor in the airline industry. It is the cornerstone to any aviation operation and expected by customers, governments, and the public in general. Aviation safety, commonly perceived as lack of accidents^v or incidents (including near

misses), is primarily achieved by an organization through compliance with prescribed standards. Airlines are subject to strict regulatory oversight from their national authorities, which prevents air carriers from deviating from safe operating standards. Furthermore, in addition to the above mentioned airlines, their suppliers are also constantly audited by regulatory agencies, manufacturers, and other airlines, often following international standards such as IATA's Operational Safety Audit Program. They are under significant pressure to conform to strict standards.

Likewise, regulatory agencies themselves are overseen by ICAO's Universal Safety Oversight Program. USOAP consists of regular, mandatory, systematic and harmonized safety audits carried out by the ICAO Secretariat in its 189^{vi} Contracting States. The audits assess the level of implementation of ICAO Standards and Recommended Practices, identify safety concerns or deficiencies, and provide recommendations for their resolution. As a result of standardization initiatives, such as ICAO's Standards and Recommended Practices and other regulatory oversight, the airline industry has achieved considerable safety improvements since the 1960s. During these last decades, international aviation has witnessed a decrease in the rate of civil aviation accidents.^{vii}

Of course, operators are still prone to errors that are not always preventable through regulatory oversight. Despite this, the carrier is still responsible to follow safe operational practices to prevent accidents or incidents and is mandated by its national authority to monitor its internal processes constantly to ensure that deviations are adequately addressed. For instance, complying with prescribed maintenance standards could, theoretically, maintain the probability of an accident due to mechanical failure at 1E-9 (1 event per 100

^{iv} See: ICAO News Release (PIO 05/06). *ICAO and IATA Agree to Share Information from Safety Audits*. Montreal, Canada, 31 March 2006.

^v ICAO defines an airplane accident as the following: an occurrence associated with the operation of an airplane that takes place between the time any person boards the airplane with the intention of flight and such time as all such persons have disembarked, and in which 1) the airplane sustains substantial damage; 2) death or serious injury results from being in or upon the airplane, direct contact with the airplane or

anything attached thereto, or direct exposure to jet blast.

^{vi} This number is current as of the date of authorship of this paper. See: <http://www.icao.int>.

^{vii} Statistical Summary of Commercial Jet Airplane Accidents Worldwide Operations 1959 – 2004, Boeing Commercial Airplanes, May 2005.

million opportunities). This is the acceptable level of safety risk for an individual catastrophic failure, as defined by national authorities during aircraft certification.

An airline is required to manage its operations adequately to ensure that its service (air transportation) is delivered in an efficient manner in order to satisfy stakeholder expectations. As an intricate network of departments, employees, contractors, and regulators interacting with each other, an airline, in order to conduct a safe operation, needs to understand the complexities associated with its operations and develop, implement, and monitor control systems that will ensure compliance with safety standards. Moreover, the management of safety requires the organization to manage proactively hazards particular to its operations. Safety management has been recognized as a key aspect of an airline's operation and is now a regulatory requirement in countries like Australia, Canada, and the United Kingdom. It is now recognized that the implementation of a safety management system (SMS)^{viii} is a contributor to further reductions in aircraft accidents and incidents.^{ix} Thus, we propose that an adequate management of safety is an indicator of the performance of an organization.

There are two indices to consider for measuring safety performance: accident rate and incident rate per departure. We have obtained the rate of accidents per million departures as well as the rate of incidents per million departures. Although it is generally accepted that only 60% of aircraft accidents can be attributable to the airline,^x it is assumed that the carriers in this study are equally exposed to external hazards; in other words, they are subject to the same operational conditions. We have also used the rate of incidents per million departures to obtain performance measurements from

^{viii} For national authorities, a draft Safety Management Systems manual has been released by ICAO (Doc 9859).

^{ix} The facts in this paragraph have been provided by Haile Belai, Chief, Universal Safety Oversight Audit Section in an interview with Triant Flouris on 1 October 2005 in Montreal, Canada.

^x Statistical Summary of Commercial Jet Airplane Accidents Worldwide Operations 1959 – 2004, Boeing Commercial Airplanes, May 2005.

carriers that have not had accidents because as a safety performance indicator these incidents can be a reflection of escape systems or control systems an airline has in place.

To observe if safety performance corresponds with other performance indicators, we have measured another set of indicators closely related with the customer experience. We have considered only on-time performance as performance indicators related to customer perception. Since customer preference for an airline is driven by the schedule offering (Carrier, 2003), we believe that compliance with the published schedule is a primary performance index. We have chosen two indices: on-time performance (OTP) and schedule compliance.

OTP depends mostly on variables external to the airline, such as weather, security, and air traffic congestion. On average, only 4.44%^{xi} of schedule deviations are attributable to the airline. However, strategic choices such as airport selection, ground handling providers, and route selection are factors under the control of the carrier and might have an impact on on-time departures. On the other hand, the schedule compliance index is affected by the number of cancelled flights, which is more closely linked to the airline's ability to align its operations with the published schedule. This reflects the ability of the carrier to manage its internal processes to ensure that all elements (e.g. aircraft availability, crew scheduling, ground handling services, etc.) affecting the operation are in place. We believe that an airline's on-time performance record might be partly a result of the effectiveness of the airline's management system, which includes the kind of business model chosen.

LITERATURE REVIEW

According to the academic discipline from which they originated, definitions of organizational culture vary. Business schools have the tendency to define organizational culture as phenomenon that can be managed, yet sociologists and anthropologists stress the uniqueness of individual organizations. The latter believe this uniqueness is a historically

^{xi} Source: Bureau of Transportation Statistics: http://www.transtats.bts.gov/OT_Delay/OT_DelayCa use1.asp, April, 2005.

derived subjective phenomenon that goes beyond simple management. At the same time, organizational psychologists with an empirical background believe that organizational culture can be broken down in its component parts and then studied part by part.^{xii}

We define organizational culture as the values, beliefs, assumptions, rituals, symbols, and behavior that define an organized group, especially in relationship to other organized groups. The visible part of organizational culture consists of observable behaviors and recognizable manifestations, for instance members' uniforms, symbols and logos, organizational routines and rituals, and printed documents. At its most fundamental level culture consists of the values, beliefs, and the subconscious assumptions that provide the logic which guides the members' behaviors.

The management of safety in the aviation industry has been linked to organizational culture. In fact, the proactive management of safety, including SMS initiatives, are dependent on the establishment of a hazard reporting culture (Reason, 1998). The important aspect of organizational culture vis-à-vis aviation safety outcomes is the underlying or deep culture. The visible aspect of culture is only procedural and is based on an organizational symbology. For instance, an employee, who is dissatisfied with his organization and not performing his duties to high standards, will still wear the company uniform to work. Therefore, in this scenario, the values, beliefs, and subconscious assumptions of the employee, vis-à-vis his organization, are less than optimal and yet his appearance will appear normal.

The cultural strength of an organization has been defined by researchers in organizational management, sociology, and anthropology in a variety of ways. It has been defined as coherence (Deal and Kennedy, 1982), homogeneity (Ouchi and Price, 1978), stability and intensity (Schein, 1992), congruence (Schall, 1983), and internalized control (DiTomaso, 1987). Cultural strength relates to whom and how many accept the dominant

values, how strongly these values are held, and how long the values have been dominant (Gordon & DiTomaso, 1992). The underlying concept to cultural strength is the way in which employees accept these values, which is to say that employees must substantively believe in their organizational culture in order for the culture to be successful.

To believe in a company's organizational culture substantively, an employee must be convinced of the superiority of this culture, and this culture must conform to her personality and national culture. However, this is complicated for organizations that exist in multicultural states^{xiii} and companies that rely on expatriate personnel, thereby bringing a multitude of people from diametrically different cultures, ethnicities, and nations under one organizational rubric. Does cultural homogeneity actually have an impact on organizational performance? Using an operationalization of cultural strength,^{xiv} two longitudinal studies have shown that a strong culture (where employees share the same cultural identity) is predictive of organizational performance as measured by short-term profits and growth in assets (Denison, 1990; Gordon and DiTomaso, 1992).

We cannot make similar claims about the relationship between cultural homogeneity and organizational behavior and flight safety because it has not been tested. However, if the assumptions of this paper are correct vis-à-vis the relationship of organizational behavior based on organizational culture and safety, then a careful study linking organizational behavior and safety will demonstrate the validity of our assumption. A research project as such will be

^{xii} Specific academic works corroborating these definitions per discipline follow in subsequent paragraphs.

^{xiii} Our opinion on this subject is different than what the literature asserts. We do not believe multicultural states to be a major problem because in these diverse states the relevance of a national culture, which goes beyond cultural or ethnic diversity, unifies people under one national framework. In other words, national culture is more important than any sub-culture in guiding people's actions in organizational settings. The United States is a good example of such a case.

^{xiv} Cultural strength was measured based on the consistency rather than the content of employee responses to survey items about organizational culture.

valid and provide airlines with the evidence and procedures they will need to implement organizational behavior changes to aid their respective organizational cultures for the ultimate goal of safety.

METHODOLOGY

We grouped the airlines that comprise our sample into three categories for purposes of comparison: mainline carriers, low-cost carriers, and regional carriers. We will attempt to associate these categories with different business models and assert that each of these groups exhibit different behavior in terms of their strategic choices and organizational performance.

The selection of the airlines studied was not random. Rather, the major criteria used for this selection was availability of data as well as volume of flights. Obviously, airlines for which data was unavailable or was incomplete could not be studied. Furthermore, studying airlines with the highest volumes of flights was necessary from a statistical analysis perspective so that the consistency of comparison and the highest possible validity was assured for our sample. Charter airlines were not included in the sample for two reasons. First, published data for charter carriers is not of good statistical quality, and, second, the regulatory framework that governs charter airline operations is not harmonious to that of scheduled carriers; thus, any comparisons would be unreliable.

Therefore, in constructing the study's sample, we used 13 U.S. scheduled carriers with the highest volume of flights per year for the period 2000-2004. For the mainline carrier group, we used the top five scheduled carriers in the U.S. by number of departures. We retained only the top four low-cost carriers (as defined by the FAA classification) due to limited availability of data for a fifth subject. Similarly, we used the top four regional carriers by number of departures. Data was filtered to retain only scheduled revenue departures (charter operations performed by scheduled carriers were not included in this study).

We utilized the on-time performance database published by the Bureau of Transportation Statistics (BTS) in order to collect on-time performance and compliance

schedule variables. For the purposes of our study and for analytical purposes, we define on-time performance as the ratio between the number of flights that arrived on time (within 30 minutes of the scheduled arrival time) and the total number of scheduled flights. Schedule completion percentage is the ratio between the number of flights scheduled and the number of flights completed.

On-time performance and schedule compliance were obtained from the "Airline On-Time Performance Data" database from the Transtats website, published by the BTS.^{xv} OTP was calculated by obtaining the number of late flights (more than 30 minutes of the scheduled departure time) by carrier. Monthly results were collated by carrier to obtain annual figures by using a pivot table in a spreadsheet. In a similar manner, traffic data (number of departures) was obtained from the "Air Carrier Statistics (Form 41)" database from the Transtats website, published by the BTS. Finally, the OTP for each carrier, by year, was obtained by calculating the ratio between the number of on-time flights and the total scheduled revenue departures.

Schedule compliance figures were also obtained from the OTP database from the Transtats service. Monthly figures by carrier were obtained by using a pivot table in a spreadsheet. OTP figures were pooled by group by considering each group as a single carrier (adding all the departures) rather than obtaining an average of their individual results. The schedule compliance index was obtained by averaging yearly results of the airlines within the group.

Furthermore, the FAA's accident and incident database provided good quality data on airline incidents from 2000-2004, which were attributable to scheduled carriers chosen for the study. From the National Transportation Safety Board's database, data on accidents occurring between 2000 to 2004 were extracted that were attributable to the air carriers chosen based on the above described criteria. The events from September 11, 2001, were excluded from the

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http://www.transtats.bts.gov/OT_Delay/OT_DelayCauses1.asp, April, 2005.

study as they would add a significant bias to the comparison. Filtering the data by using a database application, the number of accidents and incidents for this five-year period were obtained. The index was produced by dividing these figures by the traffic data obtained previously. We have adjusted the figures to use number of accidents and incidents per million

departures to make the data comparable with international publications.

The data obtained for safety and on-time performance and safety indices for both individual airlines and control groups from January 1, 2000, to December 31, 2004, has been collated, and the results are shown in tables 1 and 2.

RESULTS

Table 1. Comparison of pooled performance indicators for three carrier types (2000-2004)

Carrier Type	ACCIDENT RATE (Per million departures)	INCIDENT RATE (Per million departures)	On-Time Performance	Schedule Compliance
Mainline carriers	4.98	31.29	80.8%	97.54%
Low-cost carriers	2.38	13.91	82.4%	99.43%
Regional carriers	3.91	22.88	79.5%	98.37%

Table 2. Comparison of performance indicators among individual airlines (2000-2004)

Carrier	ACCIDENT RATE (Per million departures)	INCIDENT RATE (Per million departures)	On-Time Performance	Schedule Compliance
<u>Mainline carriers</u>				
Airline 1	6.91	28.17	81.2%	97.40%
Airline 2	4.42	24.93	78.5%	95.81%
Airline 3	4.19	34.55	80.7%	97.78%
Airline 4	6.14	33.79	82.1%	98.02%
Airline 5	1.77	38.88	82.2%	98.69%
<u>Low-cost carriers</u>				
Airline 6	1.65	13.39	82.6%	98.82%
Airline 7	-	25.47	83.6%	99.79%
Airline 8	13.02	19.53	79.2%	99.53%
Airline 9	6.91	6.91	81.0%	99.56%
<u>Regional carriers</u>				
Airline 10	2.68	18.75	81.1%	99.27%
Airline 11	4.34	31.49	79.7%	96.60%
Airline 12	3.63	18.17	78.7%	98.98%
Airline 13	3.59	1.80	78.4%	98.62%

DISCUSSION

This exploratory study suggests that low-cost carriers might be able to achieve a better organizational performance than mainline or regional carriers due to their strategic choices and organizational cultures. One important point of explanation in the research is that national authorities classify, in the LCC category, airlines that have not fully followed the low-cost

business model. However, in this study we only consider two airlines in the U.S. as true low-cost carriers, Airline 6 and Airline 7. Their strategic choices include aspects such as extended fleet utilization, a primarily third-generation aircraft fleet, and a simplified business structure. We hypothesize this might improve visibility of internal processes and enhance safety performance.

We have noted that the four performance indicators vis-à-vis safety and operational performance are in line with the three control groups (mainline, LCC, regional). LCCs are consistently superior to mainline carriers and

regional airlines in all four indicators, and, consequently, safety performance is notably superior in the LCC group. Looking at individual carriers, it appears that the results are equally consistent, with only one exception.

Table 3. *Comparison of the three business models*

	Fleet utilization	Choice of airports	Fleet planning	Cost focus
Mainline	8-11 hours per day	Hubs and main city airports, some secondary airports connected to hubs	Fleet mix to match demand by route/schedule	Some frills, diverse network
LCC	12+ hours per day	Typically secondary airports	New generation, mostly single-type aircraft fleet	No frills, simplified business structure
Regional	13+ hours per day	Hubs, main city airports, and secondary airports	1-3 aircraft types	Dependant on mainline carriers' contracts

CONCLUSION

The results obtained by this study show that carriers successfully following a low-cost business model consistently exhibit better performance in both safety and operational indices. Strategic choices made by low-cost carriers might influence performance due to several factors. First, fleet choice, newer (third generation) aircraft, are less prone to accidents^{xvi} than first and second-generation aircraft. Secondly, a single aircraft type might have more impact on operations than just economies of scale. Unexplored issues, such as the avoidance of constant flight crew training transitions between aircraft types, might influence (i.e. reduce) crew-related incident or accident. This is particularly relevant considering that flight crew related events account for 54% of all aircraft accidents.^{xvii} Other strategic choices made by following a low-cost business model might also help explain the better on-time performance figures, such as the choice of less congested airports, simpler organizational structures, and a focus on aircraft turnaround.

There are several issues that airlines need to address in order to enhance their safety training by basing it on a strong organizational culture basis and, thus, contributing to their overall safety and operational efficiency records.^{xviii} As a first step, clear organizational standards^{xix} and policies need to be set. These standards need to be clear enough so that they explicate the airline's goals and procedures, not only by obeying regulatory standards but also by proactively managing safety. Company publications and other documents can provide an opportunity to strengthen company culture by articulating the values and establishing the norms. Moreover, management always needs to establish a proper tone and thoughtful approach to its intra-company communications, sending messages centered around building community

^{xvi} Statistical Summary of Commercial Jet Airplane Accidents Worldwide Operations 1959 – 2004, Boeing Commercial Airplanes, May 2005.

^{xvii} Ibid.

^{xviii} For a detailed discussion of links between organization culture and airline safety performance see: Flouris, T. "Organizational Behavior as the Answer to CRM Effectiveness: The Creation of a Company Culture." *Conference Proceedings*, Fourth Global ICAO Flight Safety Symposium, Santiago, Chile, 12-15 April 1999.

^{xix} One example would be Standard Operating Procedures (SOPs) on crew behavior, flight safety, intercultural sensitivity, etc. that help achieve organizational standards, that is, company values and norms.

through “we” rather than the divisive “us vs. them” attitude. Multicultural and unicultural airlines, low-cost and mainline carriers, and large and small airlines should all be explicit with their directives. Airlines should adopt a “best practices” approach to standards and procedures to allow all employees to focus on the important outcomes.

Airlines should also use systems and procedures as well as training (as they do already) toward the achievement of effective safety management and, ultimately, safety. Technical skills training should remain true to its core focal point, which are technical skills. The major mistake some airlines make is to assume that Safety Management can be taught as a technical skill. Certain aspects of aviation safety are improved by technical skills,^{xx} but safety itself as an outcome is a behavioral pattern and presupposes technical proficiency. In other words, safety outcomes can be achieved through a safety attitude, and crewmembers must be predisposed to accept this attitude and, through training and thoughtful understanding, help it flourish.

The history of the airline is very important in determining the shape and magnitude of its training programs. An old, established carrier would have different demands than a new carrier; a low-cost airline will have a different training program than a mainline carrier since one core aspect of the LCC business model is cost minimization achieved by outsourcing of as many functions as possible. In addition, whether an airline has been subject to a cohesive historical background rather than the product of mergers is also very important. Airlines that have come to exist as products of mergers normally have a harder time with the cohesion and implementation of procedures since, in certain cases, the airlines that merged may have had many managerial and other incompatibilities.

The size of an airline is also an important discriminating factor in the implementation of Safety Management programs. In addition, the

country of origin of an airline is important due to regulatory frameworks and governmental involvement in the industry or even the airline itself. For example, flag carriers owned and operated by governments often have structures that resemble civil service structures. Training must comply and be compatible with these realities and cater to the existing type and strength of the airline’s organizational culture.

^{xx} For example, consider the use of specific codified language to describe certain situations and crew actions in an effort to minimize miscommunication based on linguistic misunderstanding.

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