



WORKING PAPER

ASSEMBLY — 39TH SESSION

TECHNICAL COMMISSION

Agenda Item 33: Aviation safety and air navigation monitoring and analysis

AN EVALUATION OF EFFECTIVENESS OF USOAP-CMA

(Presented by Brazil)

EXECUTIVE SUMMARY

In order to monitor the implementation of relevant Standards and Recommended Practices (SARPs) and the establishment of safety oversight measures and resources, ICAO created the Universal Safety Oversight Audit Program (USOAP). The program measures the ability of each State to publish and implement regulatory requirements consistent with the Annexes to the Chicago Convention, and its main indicator is the Effective Implementation (EI) rate.

Seeking to evaluate the influence of the EI change in the accident rate, a statistical model was developed to evaluate if the increase in EI entails a reduction in the accident rates of commercial aviation. The results show that, in fact, USOAP-CMA has been effective at increasing the States' safety aviation levels. Therefore, it is proposed a new initiative, within No Country Left Behind (NCLB) campaign, to stimulate the increase of the EI rates of States with low effective implementation in the USOAP, through a technical assistance with USOAP states that achieved higher rates.

Action: The Assembly is invited to:

- a) encourage the States with high USOAP-CMA implementation rates to provide technical assistance to the States with the lowest EI rates;
- b) call on the Council to set a global EI target for 2020;
- c) call on the Council to create a specific budget to finance technical assistance and the No Country Left Behind initiative;
- d) call on the Council to designate the ICAO Regional Offices to manage a regional budget for the NCLB initiative, receive requests for assistance and encourage regional technical assistance initiatives among states; and
- e) call on the Council to develop other evaluation methods of USOAP's effectiveness, like showed in this Working Paper, to demonstrate numerically how much the program influences civil aviation safety.

<i>Strategic Objectives:</i>	This working paper relates to the Safety Strategic Objectives.
<i>Financial implications:</i>	Yes.
<i>References:</i>	Doc 9735, <i>Safety Oversight Audit Manual</i> A Statistical Analysis of Commercial Aviation Accidents 1958-2015 WOOLDRIDGE, J. (2002), <i>Econometric Analysis of Cross Section and Panel Data</i> , Cambridge: MIT Press

1. INTRODUCTION

1.1 The 32nd Session of the Assembly reviewed and approved the recommendation proposed by the Council to address the shortcomings in the establishment of effective safety surveillance programs in the Member States: the establishment of an ICAO Universal Safety Oversight Audit Program (USOAP). The main objective of the program was to monitor the safety oversight obligations of all State entities in ensuring the implementation of all ICAO safety-related SARPs.

1.2 In the initial phase of the USOAP it was addressed only Annexes 1, 6 and 8. The first evolution of the program was to insert all safety-related Annexes in the scope of on-site audits. The next step was the main development of the program – the application of an approach based on the concept of continuous monitoring (Continuous Monitoring Approach - CMA). In this new context, in addition to off-site validation missions, specific validation missions were created (ICAO Coordinated Validation Mission - ICVM).

1.3 This Working Paper tries to analyze USOAP's effectiveness, by estimating the influence of States' level of implementation in the Program on their safety, measured in terms of accident rates.

1.4 The results demonstrate the effectiveness of USOAP. Thus, it is proposed that ICAO within the No Country Left Behind (NCLB) campaign, supports (including financially) the assistance among more developed and less developed states in the implementation of USOAP, so that the first assist the implementation of USOAP in the partners.

1.5 It is important to point out that this paper does not have the objective of measuring the risk level of civil aviation of the States, because such task would demand a much greater analysis and the availability of variables and indicators about operation profile of each state that are not in the scope of this paper. The focus here is to assess if (and how much) USOAP has been effective in its objective of improving the State's capability of surveillance of the civil aviation and, therefore, the safety levels.

2. METHODOLOGY

2.1 With audits, on-site and off-site validation missions and data upload about States in Online Framework (OLF), ICAO permanently monitors the States, assessing their compliance with the Protocol Questions and Compliance Check-lists, as well as assessing the large numbers (volume) of States' civil aviation. The quantitative of Protocol Questions (closely related to all other questionnaires) assessed as satisfactory is the method used by the organization to calculate the Effective Implementation (EI) of the USOAP. Each state has an EI, which can be updated whenever there is an audit or validation mission (on-site or off-site).

2.2 In general, it can be said that the EI measures the ability of the State to publish regulatory requirements consistent with the ICAO Annexes and, above all, ensure that they are met by the operators.

2.3 In the other hand, operators tend to follow the Standards and Recommended Practices of ICAO Annexes depending on their capacity to implement the provisions and on the enforcement policy adopted by the Regulatory Authority. Obviously, other factors may be considered that influence the compliance of these Standards by the operators, such as operational culture (which is influenced by the culture of the country) and other socioeconomic conditions.

2.4 In order to empirically estimate the influence of EI on the State's aviation safety level, consider the following equation:

$$Acid_i = \beta_0 + \beta_1 \cdot GDP_i + \beta_2 \cdot Age_i + \beta_3 \cdot EI_i + \omega_i, \quad (1)$$

where the subscript *i* denotes an ICAO member, *GDP_i* is the gross domestic product per capita of the State, *Age_i* is the average age of the country's aircraft fleet and ω_i is a random error term, supposed statistically independent of the other explanatory variables, with zero average and constant variance equal to σ^2 ¹.

2.5 Based on data provided by ICAO and International Monetary Fund (IMF), the parameters β_0 , β_1 , β_2 and β_3 will be estimated by econometric regression using the ordinary least squares (OLS) methods. Each parameter represents the isolated effect of the respective variable (GDP, Age and EI) on the accident rate of a given country (*Acid*). In this way, it may be interpreted as the influence (increase or decrease) in the country's accident rate due to a marginal change in the respective explanatory variable, kept constant every others. For example, β_2 can be seen as the impact (increase if the estimated value of the coefficient is positive or decrease if negative) due to the increase of 1 percentage point in the country EI on its aviation accident rate.

2.6 The variables used in the estimation are:

- a) *Acid_i*: the country's accident rate in 2014, calculated by the total number of accidents in 2010-2014 multiplied by 100,000 and divided by the number of departures in the same period – the same method adopted by ICAO to measure the domestic accidents levels;
- b) *Age_i*: average age of the country's aircraft fleet in 2014;
- c) *EI_i*: the effective implementation index of the country in 2015;
- d) *GDP_i*: value of gross domestic product per capita of the country in 2014.

2.7 In order to isolate each variable's effect, there must be no cause-effect relation between explanatory variables (*Age*, *EI* and *GDP*). In this sense, the average age of the country's fleet was the variable found to capture an important factor that can influence the safety of the country's air transport and which is not related to compliance with ICAO requirements². Ideally, it could be used other variables uncorrelated with EI to capture their effect on the accident rate. However, this was not possible, due to the unavailability of data for all states of ICAO.

2.8 Finally, the variable GDP captures the effect of socioeconomic conditions in the country, which, a priori, could exert some influence over the safety of operations in the States.

¹ These hypotheses about ω_i are necessary for the estimators of the model β be consistent and efficient from the statistical point of view.

² Airbus statistical analysis ("A Statistical Analysis of Commercial Aviation Accidents 1958-2015") revealed the trend of reducing accidents how much younger is the generation of the fleet.

3. RESULTS

3.1 The table below summarizes the results of the regression (1). In general, the regression shows a statistically significant result ($F = 8.13$), which means that the relationship between variables in the equation (1) is statistically significant.

Regressors	Impact on State's accidents rate
GDP per capita (GDP)	9.52e-07 (2.83e-06)
Average age of fleet (Age)	2.026** (0.528)
Effective Implementation (EI)	- 0.503* (0.213)
Constant	18.43 (17.17)
Number of states	177
R ²	0.124
F (3, 173)	8.13**

In brackets are the standard errors of the estimators
Statistical significance (error margins): **1%; *5%

3.2 With regard to the individual influence of each variable, both the average age of the fleet and the Effective Implementation have showed the expected signs. In the first case, the one-year increase in the average age of the fleet of a country entails an increase of 2,026 in the accident rate, which is consistent with the international literature. Therefore, the younger the fleet, the lower tends to be the accident rate. This relationship is statistically significant at 1% error.

3.3 This result does not mean that states with high average age of fleet are less safe. Since there are many variables that influence the safety level, our objective is to try to estimate the isolated influence of each one. For example, states can compensate this influence with an increase in the surveillance of maintenance processes. Therefore, this result can be understood as, everything else kept constant (EI, GDP, and other variables not included at the model), an increase in the average fleet's age causes higher levels of accidents.

3.4 In the case of USOAP, it appears that every 1-percentage point of the country EI increase causes a reduction of 0,503 in its regular aviation accident rate (statistically significant result at 5% error). Therefore, it is noted that the USOAP has generated the expected effects in terms of increasing the surveillance capacity of States and, thus, increasing safety. This reinforces the international strategic value of the Program and the success of ICAO to opt for its universalization and continuous approach.

3.5 It may be questioned that the State that received an ICVM after a CSA audit tend to have a superior result in the EI indicator. In order to verify this hypothesis, the equation was tested using the mentioned differentiation and the results showed no statistical significant difference.

3.6 Finally, both the constant – which has no conceptual importance – and the per capita gross domestic product showed no statistically significant impact on states' accident rate. The result of GDP per capita can be interpreted as a positive topic, because it suggests that a safe aviation is not dependent on the economic stage of the states. In this sense, an aspect that can be considered more important is the oversight capacity of the civil aviation authority.

4. OPPORTUNITIES

4.1 ICAO established the No Country Left Behind (NCLB) campaign seeking that the implementation of SARPs occur harmonically so that all States have access to significant socio-economic benefits of safe and reliable air transport.

4.2 The activities of the campaign concentrate its initiatives on States with higher accident rates or security threats and evaluate what the Organization can do to better encourage developed states to provide more comprehensive assistance to developing states. In addition, the campaign proposes that ICAO itself should provide more direct assistance to developing states by playing a more active coordination role between States and by helping to generate the political environment for states to pool resources, participate in regional efforts, intended voluntary funds and build capacity.

4.3 The results presented in the previous section (it has demonstrated the importance of implementing USOAP to increase the safety), show that it is advisable the adoption of the initiative under the No Country Left Behind (NCLB) campaign, by which the developed states in USOAP can contribute to the acceleration of the implementation by other States. Such assistance can be enhanced through the provision of financial resources by ICAO to fund training activities and support states that are willing to help others. To measure the effectiveness of this initiative, it is proposed that ICAO set a new global EI target for 2020 – given the current average of 63%.

4.4 Each ICAO regional office would be responsible for managing the initiative in its region, and shall:

- a) manage the financial resources made available by ICAO;
- b) approve the demands for technical assistance from states with the lowest EI rates;
- c) elect states with high USOAP-CMA implementation rates to provide appropriate technical assistance - leading states; and
- d) monitor the assistance and its results.

4.5 The country that should provide technical assistance not necessarily must be from the same region of the claimant States, either because it cannot exist State with this capability or even for cultural reasons. In this second case, note the case of the support provided by Brazil to Portuguese-speaking states. Although such states are in different regions, Brazil's support has been important because of some cultural aspects – such as language – that affect the increase capacity of states that receive technical assistance.

4.6 Still describing the opportunities and considering that in the regression has been used only easy access indicators that addressed all member states of Chicago Convention, ICAO should add new indicators in the equation, and develop other evaluation methods of USOAP's effectiveness. The main objective of this action, besides making the result more reliable and robust, is to improve the tools used to assess the investments and results of the Program.