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Research on Flight Operational Quality Assurance Based on ROM Concept

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Abstract. The flight operational quality management method based on Routine Operational Measure (ROM) can visually find hidden insecurity factors during flight operation and provide pilots directions in enhancing technologies and risk warning by completing collection off light segment data of aircrafts in routine operations and carrying out the analysis and research on flight data. Based on the theoretical analysis and the needs of airlines, this paper designs and implements the flight operational quality management system based on ROM so that the flight operational quality management of civil aviation of China can realize its critical transformation from a fleet to an individual and from ex-post to ex-ante.

1 Preface

According to the thirteenth five-year plan for the development of civil aviation in China, the Civil Aviation of China will basically build a safe, convenient, efficient and green modern civil aviation system by 2020. By then, the total turnover volume of air transport in China will reach 142 billion tons and above, with a passenger traffic of 720 million. In the face of rapid development of the civil aviation industry, it is urgent for us to further thoroughly enhance safety and security capability and operational quality of the industry, to improve safety management level of the civil aviation, to perfect safety supervision system of the civil aviation by improving facilities and equipment and promoting application of new technologies, thereby achieving a sustainable and safe development of the civil aviation.

It is proposed in the Implementation and Management of Flight Operational Quality Assurance (FOQA) [AC-121/135-FS-2012-45R1] Advisory Circular issued by the Flight Standard Department of Civil Aviation Administration of China that the certificate holder should carry out the Routine Operational Measure (ROM) to obtain data distribution of relevant parameters in a certain stage and conduct analysis of operation status. This refines and improves flight operational quality assurance, solves response lag and contingency in traditional FOQA management, and bids farewell to the "one
size fits all” management in exceedance events, fully tapping the value of flight data

2 ROM concept and advantages

The flight operational quality management based on Routine Operational Measure (ROM) is a management style that leads to a good sustained flight operational quality by means of completely collecting segment data in routine operations, making statistics on all data without screening, mining data by use of modern mathematical and statistical algorithms based on standard values and measurement deviation values so as to find non-ideal factors hidden in routine operations and to use the conclusion to provide suggestions for improvement to airline flight operational quality management and pilot personal flight operational quality management. Compared with the traditional FOQA, ROM has the following advantages:

(1) Complete data records and high analysis value of data: Only data of exceedance flight segments was saved in the past while now total raw data is saved without human screening because of putting emphasis on the importance of the raw data. In the past, the statistical analysis was specific to the exceedance data while it now directs at all relevant operational data, the analyzable sample size of which is expanded to thousands of times as much as that used in the traditional method, identifying the fluctuation of flight data below the limit and providing the premise of in-depth mining of data value;

(2) Pre-management capability: the analysis objects are changed from exceedance events into the total recorded data in routine operations, so that information such as habitual deviation, emerging deviation, and airport operational characteristics can be observed before an exceedance occurs by means of algorithms and analysis methods such as data visualization, thereby realizing early warning. Hence, a pre-management capability is possessed;

(3) For individuals, individual airports and other similar small samples: all flight segments are fully recorded, the traditional exceedance samples on which the statistics is performed are expanded to operational samples, with no blind area to small samples;

(4) Capability to identify accidental exceedance and habitual deviation: for those without being involved in any exceedance event, statistical analysis of habitual deviation and identification of emerging deviation are performed, while for those who are involved in an exceedance event, correlation analysis can be performed on the exceedance event and relevant parameter deviation, so that exceedances caused by habits and an accidental exceedance can be identified, and then different management tools can be used to achieve corrected effect;

(5) No derivative risk: the ROM system can directly perform statistical analysis on operational data or compare the statistical data with the expected value without setting exceedance value. There is no pressure on pilots and no limitation on the pilots’ techniques, thereby avoiding the derivative risk caused by setting exceedance under the traditional mode.

3 Technical architecture of ROM

Essentially, ROM belongs to the data mining application of flight data. The main technical elements to construct the ROM system include extracting key phase parameters to establish index system and carrying out data mining work on the extracted flight parameters; analyzing and proposing suggestions and measures for improvement based on data mining results.

3.1 Establishment of key parameter index system for flight

Generally, a flight segment is divided into the taxiing and takeoff phase, the initial climb phase, the cruise phase, the descent and approaching phase, the landing phase, and the go-around phase according to operational phases of civil aircraft. Before carrying out the ROM, we need to set up an index system that can reflect risk characteristics of each phase for different phases and are based on flight parameters. By measuring the flight parameters covered by the index system, the core characteristics that depict operational risks are obtained, mainly including the standard value (which refers to an ideal value after data validation, both as a target value that pilots pursue and a basis for
calculation of parameter deviation), the deviation value (which refers to the vector distance between flight data during actual operations and the standard value), the reason parameter (which refers to the parameter that gives direct guidance to the pilots' manipulation, such as takeoff elevation angle, landing slope, air speed when the flaps are extended, etc.), the outcome parameter (which refers to the parameter that needs to be further calculated or analyzed before supplying effective suggestions to pilots’ techniques, such as landing load, flare distance, etc.). Table 1 shows some of the key supervision parameters of the initial climb phase of the aircraft.

| Parameter Definition | Description | Unit |
|----------------------|-------------|------|
| ALT_QNH              | Altitude QNH | feet |
| ALT_STDC             | Altitude Standard (corrected) | feet |
| AOAL                 | ANGLE OF ATTACK INDICATED -L | deg |
| AOAR                 | ANGLE OF ATTACK INDICATED- R | deg |
| AP_EGD1              | Auto-Pilot 1 Engaged |     |
| AP_EGD2              | Auto-Pilot 2 Engaged |     |
| DRIFT                | DRIFT ANGLE  |     |
| DUAL_INPUT           | Double stick input |     |
| GPWS_PULL_UP         | PULL UP     |     |
| GPWS_TR_AHD          | Terrain Ahead |     |
| GPWS_TR_AHD_P        | Terrain Ahead PULLUP |     |
| GPWS_TR_CAU          | Terrain CAUTION |     |
| GPWS_TR_LOW          | TOO LOW TERRAIN |     |
| GPWS_TR_UP           | TERRAIN PULL UP |     |
| GPWS_WSH_CAU         | WINDSHEAR CAUTION |     |
| GPWS_WSHWAR          | WINDSHEAR   |     |
| GSC                  | Ground speed (corrected) | knot |
| GWC                  | Gross Weight in Ton (1000 Kg) | t    |
| HEAD_MAG             | Heading Magnetic | deg  |
| HEIGHT               | Height above runway | feet |
| IAS                  | COMPUTED AIRSPEED | knot |
| IVV                  | Inertial vertical speed | ft/min |
| LATG                 | Lateral Acceleration | g    |
| LATP                 | Present Position Latitude | deg  |
| LDG_SELDW            | Gear Selection Down |     |
| LONG                 | Longitudinal Acceleration | g    |
| LONP                 | Present Position Longitude |     |
| N11                  | LEFT ENG N1 TACHOMETER | %RPM |
| N12                  | RIGHT ENG N1 TACHOMETER | %RPM |
| N21                  | SELECTED N2 ACTUAL #1 | %RPM |
| N22                  | SELECTED N2 ACTUAL #2 | %RPM |
| PITCH                | CAPT DISPLAY PITCH ATT | deg  |
3.2 Data Mining Research

Data mining is a hot area of research in the field of artificial intelligence and database and an important step to discover implicit knowledge in the database. As a product that integrates multiple disciplines, data mining can make use of artificial intelligence, machine learning, pattern recognition, statistics, database and visualization technology to automatically analyze data and get potential implicit knowledge therefrom to help decision makers make reasonable and right decision. The main workflow is shown in Figure 1, in which data preprocessing, data mining model building, and knowledge discovery are included.

![Flight data mining flow chart](image)

3.3 Typical model analysis

After the flight data is processed as described in Section 3.2, it enters into the typical analysis model constructed by the research and is calculated. Based on the results of the model analysis, it can be used to guide pilots to improve their techniques. For example, we carry out relevant statistics on the flare distance from 50 feet to landing. The analysis model is shown in Table 2. A comparison of landing speeds among a pilot, a flight squadron, and all pilots of the airline is shown in FIG. 2.
Table 2 Statistical model for flare distance from 50ft to the landing

| Phase Definition | 50ft——landing |
|------------------|---------------|
| Location logic   | statistics on the flare distance The time when the radio altitude is 50ft (entry time) |
| Parameters of interest | aircraft number, flight number, takeoff/landing airport, time, air speed, ground speed, accumulated value of ground speeds of all sampling points being converted to feet, angle of elevation, wind direction, wind speed, left and right N1 rotor speed, left and right power lever angle, flap position, load value, rate of descent, control column, slope, control wheel, heading, reference speed, selected speed |

Fig.2. Graph for the flare distance from 50ft to landing

Through the statistical analysis of the pilot's landing speeds in nearly 300 flight segments, it can be clearly seen that the pilot's average landing speed is greater than the average level of the airline fleet and the squadron where the pilot belongs. Therefore, in the next training, the airline needs to train for landing control to control the speed well and prevent the risk of running out of runways.

4 Conclusion

ROM-based flight operational quality assurance can visually demonstrate the relationship between the pilot's individual technique level and the average level of the airline's overall pilots' techniques so as to guide pilots to find their own technical vulnerabilities. The analysis to routine operation deviations provides individuals prompts of risk when no flight operational quality exceedance occurs, so that the flight operational quality management of the civil aviation of China realizes an essential shift from a fleet to an individual and from ex-post to ex-ante”.

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