Modeling and Analysis of Customer Preference in Civil Aircraft Manufacturing Supervision

Yu Feng*, Hua Lei

1Production Support Engineering Department, COMAC Shanghai Aircraft Design and Research Institute Shanghai, China

E-mail: noahfeng@qq.com

Abstract. Customer manufacturing supervision of civil aircraft refers to the operator of the aircraft or its authorized entity’s supervision and inspection process during aircraft’s manufacturing and final assembly, through which the operator (airline company) ensures that the delivered aircrafts meet the requirements of approved technical standards, process specifications, and engineering documents, as well as confirming that optional components and aircraft’s layout comply with technical standards required by the purchase contract. Manufacturing supervision brings forward aircraft delivery inspection, qualitative improvement of which enables the improvement of efficiency in single aircraft airworthiness inspection, ensuring aircraft’s continued airworthiness. From the manufacture’s perspective, analyzing customer’s needs and preference on manufacture supervision in advance, taking advantage of the relatively long production cycle, disposing proper engineering solutions for manufacture deviations, reducing the business negotiation items due to deviations not only helps reach the goal of customer supervision, but also helps optimize engineering dispositions.

1. Customer preference assessment process for manufacturing supervision

1.1. Significance and content of supervision

Customer manufacturing supervision of civil aircraft refers to the operator of the aircraft or its authorized entity’s supervision and inspection process during aircraft’s manufacturing and final assembly, through which the operator (airline company) ensures that the delivered aircrafts meet the requirements of approved technical standards, process specifications, and engineering documents, as well as confirming that optional components and aircraft’s layout comply with technical standards required by the purchase contract. Manufacturing supervision brings forward aircraft delivery inspection, qualitative improvement of which enables the improvement of efficiency in single aircraft airworthiness inspection, ensuring aircraft’s continued airworthiness. [1]

1.2. The content of manufacturing supervision mainly includes the following two aspects

(1) On-site inspection: including docking inspections of critical structure, inspections before closing of critical areas, area inspection, system and functional testing, on-site tools and equipment inspection. [2]

(2) Configuration compliance inspection: including standard configuration compliance inspection, design optimization suggestions and compliance inspection, customized configuration compliance inspection, non-conformance assessment, airworthiness directive implementation inspection, etc. [3]
2. Customer preference assessment process for manufacturing supervision items
To clarify the evaluation method of customer preference on manufacturing supervision projects and to construct a reasonable evaluation model, the following evaluation process is conceived, step 1: start, step 2: Determine the single aircraft manufacturing supervision items with the airline, step 3: Analyze and evaluate customer preference on manufacturing supervision items, step 4: Propose a conclusion about customer preference on manufacturing supervision items.[4]

3. Evaluation method of customer preference on manufacturing supervision items

3.1 Establish the manufacturing supervision items
Airlines with different fleet sizes and regions of operation have different priorities during fleet operation. According to the Civil Aviation Advisory Notice "AC-21-AA-2010-16 Civil Aircraft Supervision Work Requirements", this can be divided into required inspection items and optional inspection items. Airlines select and finalize the single aircraft supervision items and draft instructions of the supervision items.[5]

3.2 Modeling and evaluation of customer preference on manufacturing supervision items
The evaluation criterion are based on the instructions of the manufacturing supervision items after the confirmation of single aircraft supervision from the airline and the compensation from historical business concession negotiation (inquiry, Concession request (CR), Customer Quality Logbook (CQLB), Design Change Request (DCR), etc, proposed by the customer but not optimized, which arise from the manufacturing supervision stage), as shown in Table 1.

| Table 1 Customer Manufacturing Supervision Evaluation Methods and Criterion |
|---------------------------------------------------------------|
| ITEM | Evaluation Criterion |
|---|---|
| **Required items** | |
| 1 | Fuel Tank | Check the internal area of the fuel tank before closing the fuel tank cover |
| | | After equipment installation is completed in the E/E cabin, check the area |
| | | Equipment installation area inspection before closing the side panel of the front cargo |
| | | Equipment installation area inspection before closing the side panel of the rear cargo |
| | | Rear accessory compartment inspection |
| | | Cargo area inspection after closing the front and rear cargo panel |
| | | Cabin emergency equipment, signs and seat inspection |
| | | Operation inspection of all cabin doors (boarding door, service door, E/E door, front/rear cargo door, emergency door) |
| 2 | Equipment compartment | Form inquiry sheets, 3pts; Form CR, 10pts; Form CQLB 10pts; Form DCR, 5pts |
| **Docking inspection of important structural** | |
| 3 | Wing and fuselage | Structural inspection of the connection area after the aircraft is assembled |
| | | Left/right wing area (flaps, slats, ailerons) inspection |
| ITEM | Required items | Evaluation Criterion |
|------|----------------|----------------------|
| Docking inspection of important structural parts | Docking the horizontal stabilizer with the elevator | Horizontal tail and elevator area inspection | Rudder area inspection | Rudder installation | Horizontal tail installation |
| Docking inspection of important structural parts | 4 | Tail and fuselage | After the landing gear is installed, check the landing gear compartment area (NLG and MLG) |
| System test and functional test | 5 | Landing gear installation | Function test of landing gear retraction system |
| System test and functional test | 6 | Landing gear retraction | Flight control system test |
| Conformance of external spraying scheme with CCAR-45 | 7 | Flight control system test | Flight control system comprehensive function test |
| Conformance of external spraying scheme with CCAR-45 | 8 | Nationality registration mark | After the painting of the whole aircraft is completed, check the outer surface area of the aircraft |
| Conformance of external spraying scheme with CCAR-45 | 9 | Operator's name and size and location of company logo | After the painting of the whole aircraft is completed, check the outer surface area of the aircraft |
| Area inspection, process inspection, function test | 10 | After the engine is hoisted, check the pylon |
| Optional items | 11 | After the APU is installed, check the APU cabin |
| Optional items | 12 | Check the waterproofing of the floor while installing kitchens and bathrooms |
| Optional items | 13 | Cockpit, galley, washroom, cabin area inspection |
| Optional items | 14 | Special inspection of aileron cabin |
| Optional items | 15 | Air Tightness Test of Crew Oxygen System |
| Optional items | 16 | On-board function test of emergency power supply system |
| Optional items | 17 | On-board function test-central warning system |
| Optional items | 18 | On-board function test of air data system |
| Optional items | 19 | Right engine installation |
| Optional items | 20 | Air tightness inspection of Cockpit |

### 3.3 Evaluation formula

The evaluation result $\beta$ comes from Formula (1). If $\beta$ is greater than or equal to 15, it shows that it concerns the customer and has an impact on the company (including the company’s concession negotiation loss and design changes); if $\beta$ is greater than 3 and less than 15, it shows that it concerns the customer but has little impact on the company.

$$
\beta = A_{XW} \times \delta_1 + B_{CR} \times \delta_2 + C_{CQ} \times \delta_3 + D_{DCR} \times \delta_4……………………………………..(1)
$$

whereas :

$A_{XW}$ ——If inquiry sheets come from the required check item, it equals to 1, and the coefficient is 3; if inquiry sheets come from the optional check item, it equals to 1, and the coefficient is 8;
If CR exists, it equals to 1, and is multiplied by a factor of 10;

If CQLB exists, it equals to 1, and is multiplied by a factor of 10.

If DCR comes from the required check item, it equals to 1, and is multiplied by a factor of 5; if DCR comes from the optional check item, it equals to 1, and is multiplied by a factor of 10.

3.4 Carrying out customer preference analysis and evaluation for manufacturing supervision items
The evaluation adopts a 10-point system and is divided into two categories, required inspection and optional inspection according to the AC-21-AA-2010-16 Advisory Notice "Civil Aircraft Supervision Work Requirements". Among them, the evaluation method of the required inspection category is that if the customer generates an inquiry sheet, it is recorded as 3 points, the formation of CR is recorded as 10 points, the formation of CQLB is recorded as 10 points, and the formation of DCR is recorded as 10 points; the evaluation method of the optional inspection category is that if the customer generates an inquiry sheet, it is counted as 8 points, the formation of CR is counted as 10 points, the formation of CQLB is counted as 10 points, and the formation of DCR is counted as 10 points.

A) (15 points and above) It concerns the customer and has an impact on the company (including the company's concession negotiation loss and design changes).

B) (3-15 points) It concerns the customer but has little impact on the company (including the company's concession negotiation loss and design changes).

C) (below 3 points) Customer is not necessarily concerned, and the current impact is unknown.

3.5 Propose a conclusion about customer preference on manufacturing supervision items
Evaluation results indicate supervision items that concern the airlines and have great impact on the company. Manufacturing deviated parts are suggested to disposed as change for new when there is a surplus in supporting materials considering the relative sufficient time cushion during the manufacturing supervision stage. Items that induce concessions repeatedly should be subject to engineering optimization for elimination.

4. Applicable ata chapter

4.1 Confirm Manufacturing Supervision Items
Confirm Supervision Items based on the Manufacturing Supervision Instructions of an airline

4.2 Customer Preference Analysis and Evaluation of Manufacturing Supervision
According to the Model evaluation, weighted score of supervision items are computed based on their frequency of occurrence in the Inquiry Sheets, CQLB, CR, and DCR, as shown in Table 2.

| No. | Items                                      | Drawings No. | ATA  | Major            | \(A_{XW}\) | \(B_{CR}\) | \(C_{CQ}\) | \(D_{DCR}\) | Type     | Notes            | Score |
|-----|-------------------------------------------|--------------|------|------------------|-----------|-----------|-----------|-----------|----------|------------------|-------|
| 1   | Gouge on the Fuel pipe line in the right wing fuel tank | 229A7004-000-001 | ATA 29 | Mechanical System | 0         | 1         | 1         | 0         | Required | Area Inspection | 20    |
| 2   | Interference of wiring with P6 board in left sliding window | 255A1130-000-001 | ATA 55 | EWIS             | 0         | 0         | 0         | 1         | Required | Area Inspection | 10    |
5. **Raise a Conclusion on the Customer Preference of Manufacturing Supervision**

According to the model evaluation, item No.1 Gouge on the Fuel pipe line in the right wing fuel tank has scored 20 pts, related drawing 229A7004-000-001, ATA 29. This item has entered CQLB and produced CR, which raises customer concern and has an influence on the company. Therefore, when the same non-conformance occurs in the future, manufacturing supervision representative from the Airlines may recommend to replace for new in order to reduce the effect on the company during the business negotiation stage.

**Reference**

[1] Mitchell, K., Sholy, B., & Stolzer, A. (2007). General Aviation Aircraft Flight Operations Quality Assurance: Overcoming the Obstacles. IEEE Aerospace and Electronic Systems Magazine, 22(6), 9-15. doi:10.1109/maes.2007.384075

[2] Chen Lei, Tang Shuilong, Xi Juntong. Civil Aircraft Automated Assembly Production Line Planning Technical Research [J]. Aviation Manufacturing Technology, 2013 (13): 26-29.

[3] Ding Cong, Civil Aircraft Customer Supervision Research [J], Science and Technology Innovation Magazine. doi:10.16660/j.cnki.1674-098x.2016.15.109

[4] Zhang Gui Shu, Li Hong Yu, Analysis of airbus and domestic aircraft customer supervision project management difference (2018), Project Management Technology ,2018(16):58-59

[5] Le Guang, Ding Cong, Civil Aircraft Delivery Project Organization Research Project Management Technology,2017(15):103-105