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ALGORITHM FOR CHOOSING THE MOST OPTIMAL MAINTENANCE COMPANIES

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Abstract

The algorithm for choosing the most optimal Maintenance Company is considered. The cost and quality rates such as Maintenance Cost, the Cost of Waiting Lines, the Costs of Aircraft Shipping to Maintenance Station, the Cost of After-maintenance Service, the Maintenance Quality rate are described. Ranges of permissible values of these parameters are justified.

Keywords: maintenance, reliability, maintenance quality, maintenance cost.

INTRODUCTION

ICAO Members made a decision that starting from 14 November 2013 every Country should embed Flight Safety Control System which would monitor and estimate Flight Safety state, provide corrective actions for it's improving. As part of this policy Airlines which use aircrafts with maintenance programmes based on MSG logic or those that include condition monitored components or that do not contain overhaul time periods for all significant system components should develop Reliability Programs. They will be used to provide the required airworthiness and reliability level of aircrafts, early detection and prevention of components failures. This obligates airlines for continuous reliability monitoring, control and analysis of components and functional systems. And if identifying the deterioration of aviation technique reliability the necessary maintenance work should be done.

Airline profit depends on choice of Maintenance Company. The faster and better will be maintenance, the earlier airplane will be back in operation and be involved in the transportation process. Thus, airlines faces with the problem of choosing the most optimal Maintenance Company to work with. In this paper we propose an algorithm of airline management's actions to justify and validate the choice of Maintenance Companies.

1. THE ALGORITHM STRUCTURE OF CHOOSING THE MOST OPTIMAL MAINTENANCE COMPANIES

While choosing Maintenance Companies Airlines pay attention to the two main criteria – quality of maintenance and cost of maintenance. The algorithm is shown on Fig. 1 which is proposed to be used by Airlines for choosing Maintenance Companies.

As Maintenance Cost characteristics it is proposed to use the Cost of the Maintenance, the Cost of Waiting Lines, the Costs of Aircraft Shipping to Maintenance Station and the Cost of After-maintenance Service. The Maintenance Quality it is proposed to rate using special parameter *R*.

1.1. Cost of the Maintenance

For determining the Cost of the Maintenance it is used the rate *S*:

$$S = \frac{C_{TO}}{C_{\max\ TO}},$$

where C_{TO} – Maintenance Cost in the current Company; $C_{\max\ TO}$ – maximum Maintenance Cost, *S* – comparative rate that provides an estimate of the Maintenance Cost in relation to the company with the highest one. The value of Maintenance Cost rate can range from 0 to 1.

As Maintenance is random variable, the rate *S* obeys the certain distribution law. The cost of maintenance affects a large number of factors such as professional level of personnel engaged in maintenance, the cost of spare parts, spare parts availability, the excellence level of equipment with which maintenance is carried out, the number of workers engaged in maintenance, the urgency of the work, willingness of spare equipment, the level of personnel labor and production discipline, maintenance process organization, etc.

Every factor doesn't affect on the most of other factors and the impact of each factor on the final result significantly lower than cumulative effect of all factors. And, therefore, we can assume that the Maintenance Cost is normally distributed.

To estimate the Maintenance Cost it is proposed to divide the range of permissible values of the parameter *S* into intervals with limits 0.5σ, 1σ, 1.5σ, 2σ, 2.5σ and 3σ. Using the Laplace table it is set to 0.38, 0.68, 0.87, 0.95, 0.98 and 0.99 respectively. Since the maximum value of the Maintenance Cost meets the most expensive maintenance, so the choice of Maintenance Companies according to the algorithm will be carried out step by step in the following sequence: 0 ... 0.38, 0.38 ... 0.68, 0.68 ... 0.87, 0.87 ... 0.95, 0.95 ... 0.98, 0.98 ... 0.99.

1.2. The Cost of Waiting Lines

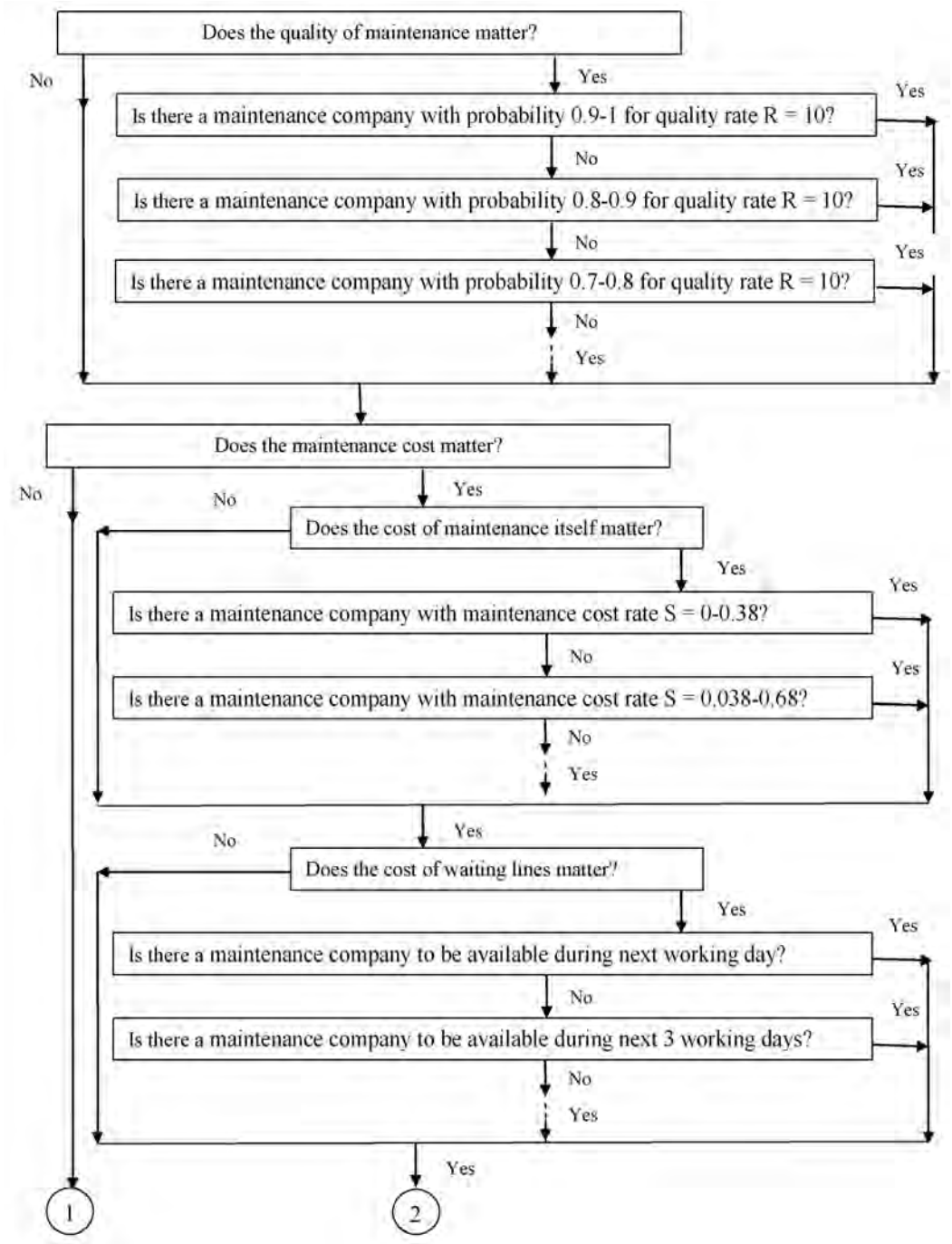
As a parameter for analyzing the cost waiting line it is proposed to use the number of working days after forwarding aircraft to Maintenance till the starting of Maintenance work. The range of permissible values of the parameter is proposed to divide into intervals with step 1, 3, 5, 10, 15, 20, etc. days.

According to the algorithm firstly selected are Maintenance Companies that can immediately take and start servicing the aircraft, such as during the next working day, during the next 3 working days, during the next 5 working days. The following periods are taken with the step of 5 days, that matches the working week.

1.3. The Costs of Aircraft Shipping to Maintenance Station

The distance between Airline and Maintenance Company is used as cost parameter of Aircraft shipping to the Maintenance Station. The maximum value matches with the half length of

the equator that is 20 000 km. It is proposed to divide this length into 10 equal intervals with a step equals 2000 km. According to the algorithm choosing of the most appropriate company with taking in account shipping costs starts within distance 0 ... 2000 km, then within 2000 ... 4000 km, then – 6000 km ... 4000, 6000 ... 8000 km, 8000 ... 10000 km 10000 ... 12,000 km, 12,000 km ... 14,000 14,000 ... 16,000 km, 16,000 ... 18,000 km and 18000 ... 20000km.



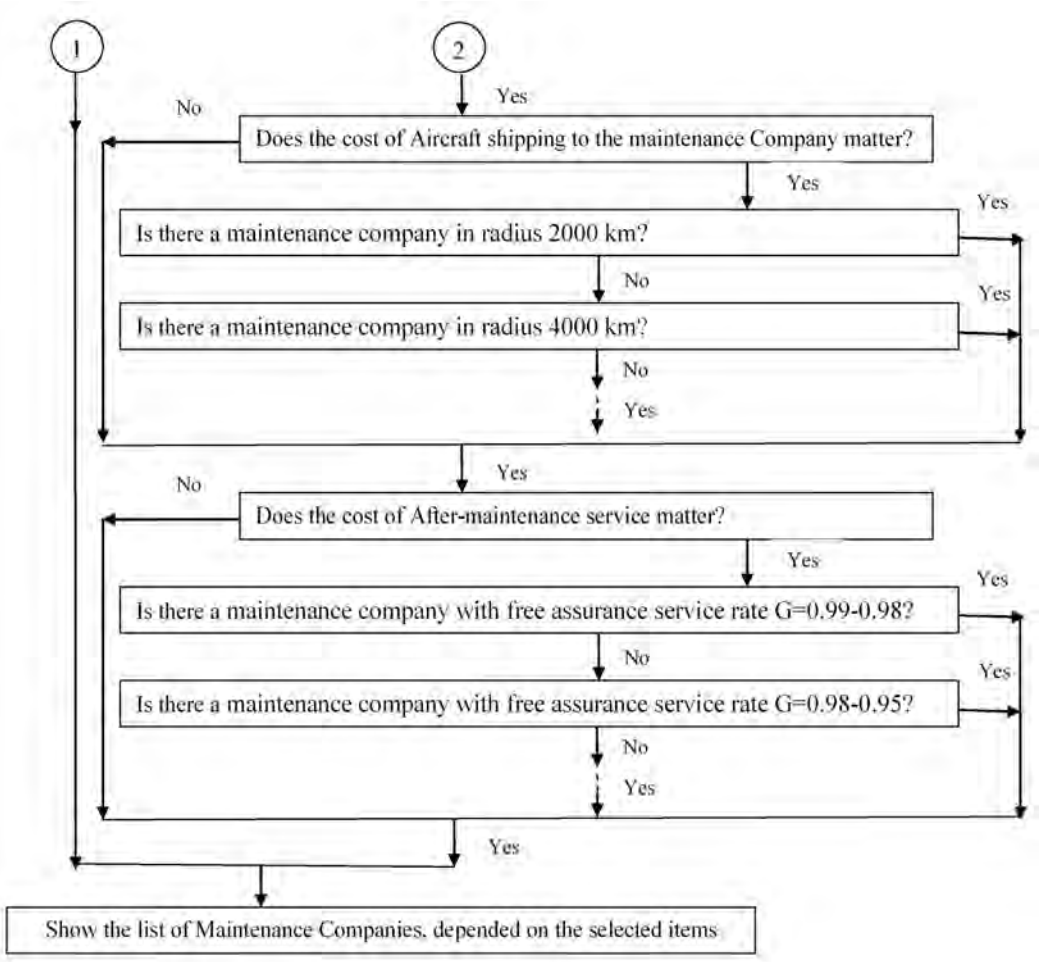


Fig. 1. Algorithm for choosing the most optimal Maintenance Companies

1.4. The Cost of After-maintenance Service

For analyzing and estimating after-maintenance Service Costs it is proposed to use the rate of free assurance service G:

$$G = \frac{T_{gr}}{T_{\max gr}},$$

where T_{gr} – free assurance service time in the current company; $T_{\max gr}$ – the maximum free assurance service time.

This rate shows the aircraft free assurance service term of some Maintenance Company in relation to the company with the maximum term. The value of parameter G varies from 0 to 1. Free assurance period dependents on a number of independent factors such as the type of maintenance work, components quality covered by assurance, maintenance quality, qualification and professional level of the personnel involved, components flight hours, etc.

Therefore, we can assume that the free assurance term is normally distributed and the range of permissible values of the parameter *G* is divided into intervals with limits 0.5σ, 1σ, 1.5σ, 2σ, 2.5σ and 3σ. They match such values according to the Laplace table 0.38, 0.68, 0.87, 0.95, 0.98 and 0.99.

Airlines are primarily interested in Maintenance Companies with long free assurance service time. Thus according to the algorithm firstly would be selected companies with parameter *G* equals 0.99 ... 0.98, and then – 0.98 ... 0.95, 0.95 ... 0.87, 0.87 0.68 ..., 0.68 ... 0.38, 0.38 ... 0.

1.5. The Maintenance Quality

Improved quality estimation rate *R* is proposed to use in the algoritm for choosing the most optimal Maintenance Companies. It is determined by comparison of the reliability rate calculating for 40-day period of aircraft operation after maintenance with average value of this parameter for the aircrafts with lifetime close to selected one. Researches shown that the rate *R* is normally distributed and the range of permissible values could be divided into intervals with limits 0.5σ, 1σ, 1.5σ, 2σ, 2.5σ and 3σ that match with values 0.38, 0.68 , 0.87, 0.95, 0.98 and 0.99 of the Laplace table.

CONCLUSIONS

The method and algorithm for choosing the most optimal Maintenance Company is developed. The method takes into account the following factors - the Maintenance Quality and the Maintenance Cost.

Using the proposed algorithm helps Airlines to choose the most optimal Maintenance Companies both from cost-quality adequacy point of view and due to loss minimization, ensuring the required level of reliability, airworthiness and flight safety.

The next step will be method approbation based on the real operation data.

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ALGORYTM WYBORU OPTYMALNEGO SPOSOBU PROWADZENIA FIRMY

Streszczenie

Algorytm wyboru optymalnego utrzymania Firmy musi byc przemyślany. W publikacji opisane są koszty i jakość. Przytoczono takie wskaźniki jak koszty utrzymania, koszty przestojów, koszty przewozów lotniczych, koszty uruchomienia serwisu, prędkość dostaw, jakość wykonania, konserwacja. W artykule uzasadniono zakresy dopuszczalnych wartości tych parametrów.