

**ECONOMIC DEVELOPMENT STRATEGY**

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**Wang Bo****LOGISTIC APPROACH TO INTERACTION BETWEEN AN AIRLINE AND A FUEL SUPPLIER**

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**Abstract.** This article discusses optimization of jet fuel supply to airlines under conditions of the surge in jet fuel prices by forecasting of airline's fuel demand and planning the interaction between an airline and fuel suppliers.

**Keywords:** airline; demand forecast; jet fuel; logistic approach.

**1. Introduction**

In modern economy interaction between an airline and a fuel supplier is one of the main points in the logistics technology of airline's material supply. Due to the surge in jet fuel prices the share of fuel expenses in cost of operations has significantly raised in recent years and even minor changes in the jet fuel supply logistics can significantly affect the airline's competitiveness and its stability in the air transportation market.

The use of modern logistics techniques requires both improving management information technologies and major changes in the strategy of supply management through the use of supply and forecasting models as well as planning of use of material and technical resources. This approach aims to increase the competitiveness and improve the economic performance of an airline and its partners.

Theoretical and practical problems considered in this paper are related to the airline economics and may be of direct interest to airline managers. The practical relevance of this task is determined by the significant influence of jet fuel price on the financial results of the airline activity. Moreover, the trends of the recent years show that the airline's survival in the airline industry may depend on the successful solution of the stated task.

The purpose of this paper is to develop planning and optimization models of fuel supply, based on the forecasting of airlines fuel consumption, taking into account the peculiarities of service at airports.

Working conditions of many airlines are related with broad airports' geography, features of national economies, conditions and opportunities of service at different airports. One of the highlights of airline service at every particular airport is the price of fueling up and commercial terms of refueling. At the

same time the price and commercial terms may depend on the frequency of aircrafts' refueling, fuel type and quantity, the type of refueled aircraft. Taking into account the fact that a fuel supplier can also operate at different airports, where the airline carries out flights, the price and commercial terms of fuel supply can also depend on mutual crossing of "geographies" of the supplier and the airline, which carries out flights.

Besides the fuel price, the essential point for the airline in business conditions is the order of payment for purchased fuel, which may include the need for advance payment, the possibility of deferred payment, as well as changes in fuel prices, related with the stated potential.

Thus, for the airline the mentioned options of fuel supply and payment are related to the dynamics of the "return" cash flow. The model of the process will allow to plan and optimize the fuel supply to the airlines with relation to financial cash flow, which in turn can significantly affect the financial situation in the airline, not only in the certain period, but also in general.

Building a model of jet fuel supply, we assume that the airline has a forecast plan of flights to the annual term. We also assume that there is a forecast of the revenue part of the financial flows, connected with the sale of air transportation services. It should be noted that the revenue part of the financial flow should also be the subject of planning and optimization, however this issue, as well as the issue of the mutual influence of income and expenses flows, we are planning to consider in the next article.

**2. Mathematical model**

We split a scheduled interval, which is assumed to equal a year, for the periods  $t \in T$ . Depending on

the model specifications the periods  $t$  can equal a month, a week or even a day. "Geography" of airline's work is represented as set of airports  $A$ . In each period  $t$  for each airport  $a \in A$  in accordance with the plan of flights we defined set of aircraft departures  $V_{ta}$ . Each departure  $v \in V_{ta}$  is performing a particular flight or its part and is characterized by the following parameters: aircraft type, transit range, aircraft load, fuel type, the minimum  $\tau_{vta}$  and maximum  $\tau_{vta}$  fuel volume possible on the board at the time of departure. As the fuel volume  $\tau_{vta} \in [\tau_{vta}, \tau_{vta}]$  which is on the board at the time of departure, can change a possible payload of the aircraft, we enter the function  $\Delta c_{vta}(\tau)$ , which will adjust the forecasted income from the flight, according to the fuel volume at the board, which increases or reduces with respect to the normative for the considered departure. The fuel volume at the time of departure also influences the fuel consumption rate during the flight, so it is also necessary to consider the function  $\Delta \tau_{vta}(\tau)$ , which determines the fuel consumption for a given flight, depending on its initial volume on the board  $\tau_{vta}$  at the forecasted payload.

Organization of aircraft fueling at the airport can be performed on different commercial terms. Fuel can be purchased from the fueling complex on a common basis at the price of tariffs registration authority. At some airports, under certain conditions, it is possible to open a storage card. In this case, the airline can purchase fuel from the wholesale operator. It is also possible to purchase fuel from the operator, which has its own card in the fueling complex. We mark the set of possible options of refueling of aircrafts of the airline at the particular airport. We believe that the options do not depend on periods and are constant throughout the predication interval. Each option  $b \in B_a$  of the fueling is related with the fuel price  $c_{ba}$  and with time displacement of payment for the fuel (usually it is a prepayment). The condition for the possibility of using a particular option of the fuel supply at the airport can be a certain annual refueling capacity, which is required minimum for the fuel supplier. Formally, it is also necessary to state the annual maximum in order to model the lack of refueling at the airport, if any option of fuel supply has been chosen.

A necessary condition for financial stability of the airline is excess of available funds over expenses in each period of operation. We mark the revenue part of the financial flow in each reporting period  $\Phi_t$ , and the share of funds that can be used for fuel purchase  $k < 1$ .

As an optimization criterion we propose to consider the amount of annual costs for the fuel purchase and the amount of possible losses of revenue if the quantity of fuel on the board deviates from the nominal. The aim is to find the lowest criterion value by selecting options of the commercial terms of fuel supply at airports  $x_{ba}$  and the volume of refueling of aircrafts before departure  $z_{vta}$ .

The mathematical model can be written as follows

$$\sum_{t \in T} \sum_{a \in A} \sum_{v \in V_{at}} \left( \Delta c_{vta}(\tau_{vta}) + \sum_{b \in B_a} z_{vta} c_{ba} x_{ba} \right) \rightarrow \min_{z_{vta}, x_{ba}} \quad (1)$$

$$\sum_{l \in T_l} \sum_{a \in A} \sum_{v \in V_{al}} \left( \Delta c_{vta}(\tau_{vta}) + \sum_{b \in B_a} z_{v(l+\Delta l)_{ba}} c_{ba} x_{ba} \right) \leq k \sum_{l \in T_l} \Phi_l, \quad t \in T \quad (2)$$

$$\tau_{vta} = \tau_{p(vta)} - \Delta \tau_{p(vta)}(\tau_{p(vta)}) + z_{vta}, \quad t \in T, a \in A, v \in V_{ta} \quad (3)$$

$$\sum_{b \in B_a} x_{ba} \leq 1, \quad a \in A \quad (4)$$

$$\sum_{b \in B_a} z_{ba}^L x_{ba} \leq \sum_{t \in T} \sum_{v \in V_{at}} z_{vta} \leq \sum_{b \in B_a} z_{ba}^U x_{ba}, \quad a \in A \quad (5)$$

$$\tau_{vta} \in [\tau_{vta}, \bar{\tau}_{vta}], \quad t \in T, a \in A, v \in V_{ta} \quad (6)$$

$$x_{ba} \in \{0, 1\}, \quad a \in A, b \in B_a \quad (7)$$

$$z_{vta} \geq 0, \quad t \in T, a \in A, v \in V_{ta} \quad (8)$$

Let us explain the model formulas:

(1) – optimization criterion; (2) – the requirement that in any period, the sum of accumulated expenses, related with the payment of fuel and potential losses in income does not exceed a prescribed share of the amount of accumulated income; (3) – the condition of "connection" of fuel consumption rate – fuel volume on the board at the time of departure from the particular airport depends on the volume in the previous airport, fuel consumption during the flight and refueling in the current airport. The function  $p(vta)$  determines the previous airport, period and departure for the aircraft. Formally, in the model should be specified a zero period with information

about the remaining fuel in the aircrafts; (4) – a requirement not select more than one of the available options of fuel supply at the airport; (5) – a requirement for an annual minimum purchases of fuel at the airport, as well as a formal maximum limit of purchases; (6) – the definition of a possible refueling of the aircraft; (7) – the definition of a variable range  $x_{ba}$ ; (8) – the restriction of variables  $z_{via}$ .

Simple transformations can reduce the proposed model to a linear programming problem, which can be solved with different software solutions. If you fill the model with data and make calculations you will be able to answer the questions of where, in which volume and under what conditions the airline can fuel aircrafts in the most profitable way, what kind of agreements to conclude with fuel suppliers, what amount of financing is needed for fuel purchase for different periods of the planned interval.

### 3. Conclusions

Economic and mathematical modeling is an essential element of logistics research. Logistics of interaction between an airline and a fuel supplier can be represented as a dynamic optimization model, which respond not only to the quantitative questions: how much fuel should be purchased, but also organizational questions: what conditions and what supply options to choose.

### References

[1] *Pleschinskii A.S.* Optimization of Inter-firm interactions and intracompany management decisions. – M. : Nauka, 2004. – 252 P.

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#### **Ванг Бо. Логістичний підхід до взаємодії авіакомпанії з постачальниками палива**

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У статті розглянуто питання оптимізації забезпечення авіакомпанії авіапаливом в умовах суттєвого росту цін на нього, шляхом прогнозування й планування потреби авіакомпанії у паливі та планування взаємодії авіакомпанії з постачальниками авіапалива.

**Ключові слова:** авіакомпанія; авіапаливо; логістичний підхід; прогнозування потреби.

#### **Ванг Бо. Логистический подход к взаимодействию авиакомпании с поставщиками топлива**

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В статье рассматриваются вопросы оптимизации обеспечения авиакомпании авиатопливом в условиях существенного роста цен на него, путем прогнозирования и планирования потребности авиакомпании в топливе и планирования взаимодействия авиакомпании с поставщиками авиатоплива.

**Ключевые слова:** авиакомпания; авиационное топливо; логистический подход; прогнозирование потребности.

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