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A Dynamic Programming Model to Optimize the Capacity Control with the Priority of Air Cargo

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Abstract

This paper concentrates on the problem of the air cargo space management strategy with a comprehensive, abstract and simplified way, on the basis of the actual characteristics of transport demand in China's air cargo market. We focus on the urgent transportation of goods and general cargo transport whose time requirements are different. The paper first proposes a single-leg cargo space management dynamic programming model according to the different time limit of different kinds of goods, and then the two dimensional single-leg air cargo problem is transformed into one dimensional two-leg airline network problem. After that, we use the expanded method of dynamic programming decomposition to solve the model. A numerical example is solved and simulated to verify the effectiveness of the program.

Keywords: *Air Cargo, Cabin Inventory Control, Dynamic Programming*

1. Introduction

Air cargo service has been quickly and globally developed since the mid-1990s. There are also many literatures about the cabin inventory controlling management, that is, to gain the maximal expected income by reasonably receiving and refusing the order. Since Littlewood proposed the cabin inventory controlling model [1], many research fruits emerged such as the classical reviewing papers by McGill and Van Ryzin [2], Talluri and Van Ryzin [3].

However, due to the multidimensionality including the weight, volume and shape and so on and the multiple types of goods including urgent and ordinary orders, the cabin inventory control problem cannot simply replaced with the passenger space control problem. Kasilingam initially analyzed the yield management of air cargo transport and passenger transport and developed four analysis steps and the model of the yield management of air cargo transport [4]. Kasilingam developed a simple model on the one-dimensional space by minimizing the total cost considering the given transport capacity, overbooked cost, and then obtained the optimal overbooking levels [5]. Luo et al. extended Kasilingam's one-dimensional model and proposed a two-dimensional overbooked model for air cargo transport. They divided the overbook of goods into the volume and weight, and developed the model with the minimal cost as the objective by the rectangular approximation method and marginal analysis [6]. Amaruchkul et al. introduced a Markov decision-making model and discussed the cabin inventory controlling problem when the weight and volume of goods are random in a multi-dimensional space [7]. Levin and Nediak divided the agents into contract customers and treaty customers, developed a dynamic shipping space controlling model and verified the effectiveness by a numerical example [8].

Above all, although many scholars paid much attention on the cabin inventory controlling problem, most of them aim at the passengers transport and shipping container transport and so

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on. There are less literatures aiming at air cargo transport. In fact, it is always an important spot to efficiently draw up a sales plan of shipping space according to different categories and required transport time of goods. The rest of this paper is as follows. In Section 2, a cabin inventory controlling problem for air cargo is introduced. Then the model building process is exhibited in Section 3. The solution method is introduced in Section 4. A numerical example is proposed in Section 5 to verify the effectiveness of the proposed model and solution method. Finally, some conclusions are summarized in Section 6.

2. Problem Statement

In China, air cargo carriers usually receive the cargo book 48 hours in advance. In high season, the flight often appears obvious shortage of supply. The tons control department traditionally receives and transports goods according to the arrival order. If the capacity of freight space is not enough, they will refuse the later arrival goods. There exist two kinds of goods including urgent and ordinary order in the whole progress of booking cargo space. The urgent order usually requires a higher price and simultaneously the high timeliness without the delay. The ordinary order usually requires a lower price and simultaneously the low timeliness permitting the suitable delay. Therefore, although traditional strategies guarantee the complete transportation for those received goods and achieve a high customers' satisfactory level, they usually ignore the difference between the urgent and ordinary goods. On one hand, they provide the ordinary order with the excellent service which is only for the urgent order and therefore the cost for service is added. On the other hand, the tons control department has to refuse the later arrival urgent order since some early arrival ordinary order takes the cargo space.

Therefore, how to reduce the loss of potential revenue as far as possible under the assumption that the service quality is not reduced is the research spot in this paper. The object in this paper is to maximize the total revenue and minimize the penalty cost by reasonably receiving and transporting goods.

3. Model Building

Assume that the maximal load carrying capacity and volume of flight *A* are k_w and k_v respectively during the peak period. The time of booking cargo space is discrete, denoted by t (0⩽ t⩽ T). t = 0 denotes the start of booking and $t = T$ denotes the end of booking that is the leave of flight after loading goods. When describing this problem, the interval is so thinly divided that there is only one arrival of the order in every interval t. Assume that *i=1* denote the urgent order, *i=2* denote the ordinary order and the unit price and penalty cost are r_i and h_i. Because the urgent order cannot usually be delayed and the ordinary order can be properly delayed, let Error! Reference source not found. and $h_2 = r_2$. During the booking period, the weight w_i and volume v_i of the *i*-th demand are random variables following the distribution ϕ_i and φ_i, respectively and the income of the i-th demand is $r_i w_i$. Let p_{it} denote the probability of the arrival of the i-th demand in the interval time t and $p_{ot} = 1 - \sum_{i=1,2} p_{it}$ be the probability that there isn't any one order in time t.

If $t < T$, let $U_t(x_w, x_v)$ be the maximal expected revenue from time t to the end of booking cargo space when the available loading capacity is x_w and the volume is x_v. Then the Bellman equation of $U_t(x_w, x_v)$ can be described as follows,

$$U_t(x_w, x_v) = \sum_{i=1,2} p_{it} \max\{U_{t+1}(x_w - w_{it}, x_v - v_{it}) + r_i w_{it}, U_{t+1}(x_w, x_v)\} + p_{ot} U_{t+1}(x_w, x_v) \tag{1}$$

where w_{it} and v_{it} are the weight and volume of the arrival goods in time t, which are also random variables following the distribution ϕ_i and φ_i .Equation (1) means that the maximal expected revenue from time t to the end of booking cargo space when the available loading capacity is x_w and the volume is x_v should be the sum of the maximal expected revenue with some arrival goods and the maximal expected revenue without any arrival goods in time t.

When $t=T$, let $w_{ij_i}, v_{ij_i}, j_i = 1, 2, \ldots J_i$ be the weight and volume of the j_i-th goods and J_i be the total amount of the i-th goods. If the penalty cost is $C(J_i)$, it should satisfy the following programming,

$$\min C(J_i) = \sum_{i=1,2} \sum_{j_i=1}^{J_i} h_i w_{ij_i} (1 - a_{ij_i}) \tag{2}$$

$$s.t. \quad \sum_{i=1,2} \sum_{j_i=1}^{J_i} w_{ij_i} a_{ij_i} \le k_w \tag{3}$$

$$\sum_{i=1,2} \sum_{j_i=1}^{J_i} v_{ij_i} a_{ij_i} \le k_v \tag{4}$$

$$a_{ij_i} \in \{0,1\} \quad for\ all\ i = 1, 2, \quad j_i = 1, 2, \ldots, J_i \tag{5}$$

Equation (2) is the objective function to minimize the total penalty cost after loading goods. Equation (3) means that the total weight after loading goods cannot exceed the maximal weight capacity of loading. Equation (4) means that the total volume after loading goods cannot exceed the maximal volume capacity of loading. Equation (5), in which $a_{ij_i} = 1$ denotes the j_i-th can be loaded in the flight or $a_{ij_i} = 0$, is about the decision variables.

Obviously, equation (1) satisfies the following boundary conditions,

$$U_t(x_w, x_v) = -E[C(J_i)] \ \text{ if } x_w \le 0 \text{ or } x_v \le 0 \tag{6}$$

$$U_T(x_w, x_v) = -E[C(J_i)] \ \text{ if } t = T \tag{7}$$

Equation (6) denotes that the tons control department does not anymore receive the order and only consider the loading problem of goods when the volume of received goods has arrived at or exceeded the maximal capacity. Equation (7) denotes that the tons control department does not anymore receive the order and only consider the loading problem of goods when booking cargo space is over.

Let $\Delta U_{it}(x_w, x_v) = U_t(x_w, x_v) - U_t(x_w - w_{it}, x_v - v_{it})$ be opportunity cost of the i-th received goods whose weight is w_{it} and volume is v_{it} when the surplus available loading weight is x_w and surplus volume is x_v. Then equation (1) can be rewritten as follows,

$$\begin{aligned} U_t(x_w, x_v) &= \sum_{i=1,2} p_{it} \max\{U_{t+1}(x_w - w_{it}, x_v - v_{it}) + r_i w_{it}, U_{t+1}(x_w, x_v)\} + p_{ot} U_{t+1}(x_w, x_v) \\ &= \sum_{i=1,2} p_{it} \max\{r_i w_{it} - \Delta U_{i,t+1}(x_w, x_v), 0\} + U_{t+1}(x_w, x_v) \end{aligned} \tag{8}$$

It easily follows that the optimal boundary condition of receiving the *i*-th goods is

$$r_i w_{it} \geq \Delta U_{i,t+1}(x_w, x_v) \tag{9}$$

that is, if and only if the maximal expected revenue of receiving the *i*-th goods exceeds or equals the opportunity cost, the goods will be received, or the goods will be refused.

4. Model Solution

In this section, the dynamic programming decomposition proposed by Talluri and Ryzin [2] is used to approximate the optimal solution of value function $U_t(x_w, x_v)$, $0 \leq t \leq T$. A two-dimensional air cargo freight problem with single segment is firstly converted into a one-dimensional passenger transport problem with two segments. Then the dynamic programming decomposition is used to solve the unit opportunity cost of surplus available weights and volumes in time *t*, further compute the expected opportunity cost of the *i*-th arrival goods in time *t* and finally decide whether the goods is received. The detailed steps can be summarized as follows.

Step 1. Convert the transport problem.

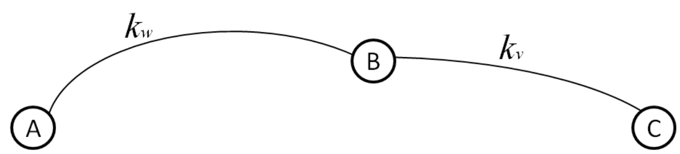

Figure 1. Process of converting the transport problem

As shown in Figure 1, the weight and volume of cargo flight are regarded as two legs (A,B) and (B,C) of passenger service, in which the available maximal seating in (A, B) is k_w (the maximal capacity of loading weight) and the available maximal seating in (B, C) is k_v (the maximal capacity of loading volume). Therefore, the two-dimensional air cargo freight problem with single segment has been converted into a one-dimensional passenger transport problem with two segments.

Step 2. Find the initial approximate solution of the opportunity cost of loading weight and volume.

After the problem is converted, the opportunity cost of loading weight and volume equals the unit opportunity cost of seat on the leg (A, B) and (B, C). According to the assumption that there is only an arrival order in the time interval *t*, the expected amounts of pre-orders of the *i*-th passenger tickets during the whole period should be

$$n_i = \sum_{t=0}^{T-1} p_{it} \tag{10}$$

Meanwhile, the numbers of passengers w_{it}, v_{it} on the leg (A, B) and (B, C) are respectively random variables subject to the distribution ϕ_i and φ_i then it follows that

$$E[w_{it}] = E[w_i] = \int_0^{+\infty} \phi_i(l) l dl \tag{11}$$

$$E[v_{it}] = E[v_i] = \int_0^{+\infty} \varphi_i(l) l dl \tag{12}$$

where ϕ_i and φ_i are the density functions of the distribution ϕ_i and φ_i as follows,

$$\phi_i(d) = \int_{-\infty}^{\alpha} \phi_i(l)dl\,,\quad \varphi_i(d) = \int_{-\infty}^{\alpha} \varphi_i(l)dl \tag{13}$$

Obviously, when $l \le 0$, it follows that $\phi_i(l) = \varphi_i(l) = 0$. The random multiple objective expected model can be described as follows,

$$\max E\{\sum_{i=1,2} f_i(x_i) - C(x_i), -C(x_i)\} \tag{14}$$

$$s.t. \quad x_i \ge 0, i = 1,2$$

where $E[f_i(x_i)] = r_i \cdot \min\{x_i, n_i\} \cdot E[w_i]$ .Take equations (2)~(5) into the above model, and we have

$$\max d_1^+ - d_1^- - d_2^+ + d_2^- \tag{15}$$

$$s.t. \quad \sum_{i=1,2} \{r_i, \min\{x_i, n_i\} \cdot E[w_i] - \sum_{j_i=1}^{\min\{x_i,n_i\}} h_i E[w_i](1 - a_{ij_i})\} - d_1^+ + d_1^- = 0 \tag{16}$$

$$\sum_{j_i=1}^{\min\{x_i,n_i\}} h_i E[w_i](1 - a_{ij_i})\} - d_1^+ + d_1^- = 0 \tag{17}$$

$$\sum_{i=1,2} \sum_{j_i=1}^{\min\{x_i,n_i\}} E[w_i] a_{ij_i} \le k_w \tag{18}$$

$$\sum_{i=1,2} \sum_{j_i=1}^{\min\{x_i,n_i\}} E[v_i] a_{ij_i} \le k_v \tag{19}$$

$$x_i, d_i^{\pm} \ge 0, a_{ij_i} \in \{0,1\} \tag{20}$$

$$\textit{for all } i = 1,2,\ j_i = 1,2,\ldots, x_i$$

In order to conveniently solve the above model, it can be simplify as follows by denoting a_i as the total order amounts of receiving the *i*-th passenger tickets,

$$\max d_1^+ - d_1^- - d_2^+ + d_2^- \tag{21}$$

$$s.t. \quad \sum_{i=1,2} E[w_i] \cdot \{r_i x_i - h_i(x_i - a_i)\} - d_1^+ + d_1^- = 0 \tag{22}$$

$$\sum_{i=1,2} h_i E[w_i](x_i - a_i)\} - d_2^+ + d_2^- = 0 \tag{23}$$

$$\sum_{i=1,2} E[w_i] a_i \le k_w \tag{24}$$

$$\sum_{i=1,2} E[v_i] a_i \le k_v \tag{25}$$

$$a_i - x_i \le 0 \tag{26}$$

$$x_i - n_i \le 0 \tag{27}$$

$$a_i, x_i, d_i^{\pm} \ge 0 \quad \textit{for all } i = 1,2 \tag{28}$$

It is easy to find the optimal solution π_w of the above model and the optimal solution π_v of its dual problem, that is, the initial approximate solution of the opportunity cost of loading weight and volume.

Step 3. Compute the unit prorated cargo rate of all kinds of goods.

The unit prorated cargo rate of all kinds of goods is the unit prorated rate for all kinds of passenger tickets on every leg after the problem is converted. Let pcr_{ij} be the unit prorated rate for the *i*-th kind of passenger tickets on the *j*-th leg, then

$$pcr_{ij} = max\left\{0, r_i - \pi_l \mid_{l\in\{w,v\}, l\neq j}\right\} \quad (29)$$

It means the expected revenue generated by goods taking up the unit weight (volume) of the flight after deducting the expected opportunity cost generated by goods taking up the unit weight (volume) of the flight when receiving the *i*-th kind of goods. Obviously, if pcr_{ij} is bigger, it means that the resource which the *j*-th leg is more intense for the *i*-th kind of goods.

Step 4. Convert equation (1) into two one-dimensional dynamic programming models.

The unit prorated cargo rate of all kinds of goods is pcr_{ij} , then equation (1) are converted into two one-dimensional dynamic programming models as follows,

$$U_{wt}\left(x_w\right) = \sum_{i=1,2} p_{it} max\left\{U_{w,t+1}\left(x_w - 1\right) + pcr_{iw}, U_{w,t+1}\left(x_w\right)\right\} + p_{0t} U_{w,t+1}\left(x_w\right) \quad (30)$$

$$U_{vt}\left(x_v\right) = \sum_{i=1,2} p_{it} max\left\{U_{v,t+1}\left(x_v - 1\right) + pcr_{iv}, U_{v,t+1}\left(x_v\right)\right\} + p_{0t} U_{v,t+1}\left(x_v\right) \quad (31)$$

Meanwhile, equations (31) and (32) satisfy the following boundary conditions,

$$U_{jt}\left(x_j\right) = E\left[C\left(J_i\right)\right],\ j = w, v,\ \text{if } x_j \leq 0 \quad (32)$$

$$U_{Tj}\left(x_j\right) = E\left[C\left(J_i\right)\right],\ j = w, v,\ ,\text{if } t = T \quad (33)$$

Step 5. Compute the unit opportunity cost of the loading weight and volume.

Let $\Delta U_{wt}\left(x_w\right)$ be the unit opportunity cost of the loading weight when the surplus available loading weight is x_w at time *t*, then we have

$$\Delta U_{wt}\left(x_w\right) = U_{wt}\left(x_w\right) - U_{wt}\left(x_w - 1\right) \quad (34)$$

Accordingly, let $\Delta U_{vt}\left(x_v\right)$ be the unit opportunity cost of the loading volume when the surplus available loading volume is x_v at time *t*, then we have

$$\Delta U_{vt}\left(x_v\right) = U_{vt}\left(x_v\right) - U_{vt}\left(x_v - 1\right) \quad (35)$$

Step 6. Compute the expected opportunity cost of all kinds of goods.

As known that the unit opportunity costs of the loading weight and volume when the surplus available loading weight and volume are x_w and x_v at time *t* are $\Delta U_{wt}\left(x_w\right)$ and $\Delta U_{vt}\left(x_v\right)$, respectively, then the expected opportunity cost of the *i*-th kind of goods with the weight w_{it} and the volume v_{it} should be

$$EC = \Delta U_{wt}\left(x_w\right) \cdot w_{it} + \Delta U_{vt}\left(x_v\right) \cdot v_{it} \quad (36)$$

Hence, the optimal boundary condition to receive the goods should be

$$r_i w_{it} - EC \geq 0 \quad (37)$$

that is, if and only if the maximal expected revenue of receiving the *i*-th goods exceeds or equals the opportunity cost, the goods will be received, or the goods will be refused.

Above all, the total algorithm of the solution method can be summarized as follows:

Procedure *Approximate the optimal solution by the dynamic programming decomposition*

Input: *Basic parameters of all goods*

Output: *Receive or refuse the goods*

Step 1. Convert the two-dimensional air cargo freight problem with single segment into one-dimensional passenger transport problem with two segments.

Step 2. Find the initial solution of the opportunity cost of loading weight and volume.

Step 2.1 Find the random multiple objective expected model as Equation (14).

Step 2.2 Convert the random multiple objective expected model into a goal programming problem as shown from Eqs. (21)~(28).

Step 2.3 Solve the goal programming problem by Lingo.

Step 3. Compute the unit prorated cargo rate of all kinds of goods as shown in Eq. (29).

Step 4. Convert the initial model into two one-dimensional dynamic programming models as shown from Eqs. (30)~(33).

Step 5. Compute the unit opportunity cost of the loading weight and volume by Eq. (35).

Step 6. Compute the expected opportunity cost of all kinds of goods by Eqs. (36) and (37). Then decide which goods should be received or refused.

5. Numerical Example

Flight A could be ordered 48 hours advance. The maximal loading weight and volume of flight A are 15,000kg and 1000m3, respectively. The unit transport prices of urgent and ordinary goods are 3.00 yuan/kg and 1.00 yuan/kg, respectively. Because the urgent goods cannot be delayed and the ordinary goods can be properly delayed, their penalty costs are 100.00yuan/kg and 1.00yuan/kg, respectively.

During the period of booking cargo space, the average arrival orders are 245, in which urgent orders take up 12% and ordinary orders take 88%. The weight and volume of urgent orders respectively follow Gamma distribution and whose density functions can be found in Figure 2 and Figure 3. The weight and volume of ordinary orders respectively follow Gamma distribution and whose density functions can be found in Figure 4 and Figure 5.

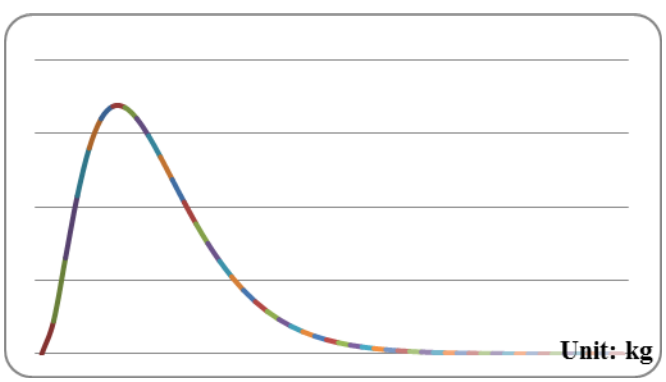

Figure 2. The density of the weight of urgent orders

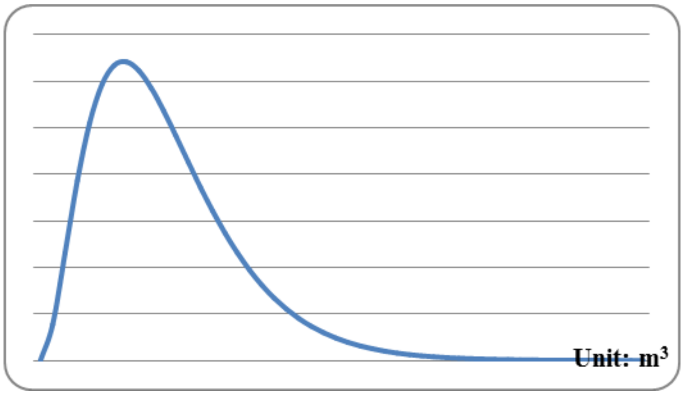

Figure 3. The density of the volume of urgent orders

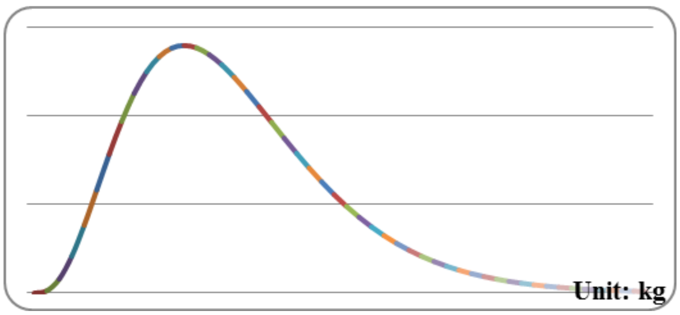

Figure 4. The density of the weight of ordinary orders

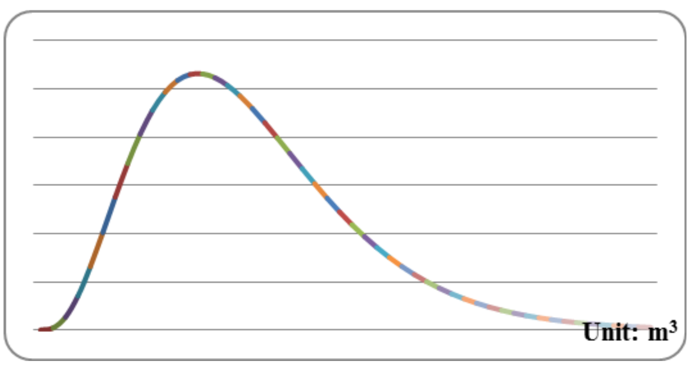

Figure 5. The density of the volume of ordinary orders

Assume that the arrival process of urgent and ordinary follows the Poisson distribution during the whole period of booking cargo space. It follows that the computing process of capacity control model during the peak period and computing results are as follows,

(1) Find the initial approximate solution of the opportunity cost of loading weight and volume. It is easily to obtain that the expected number of urgent orders $n_1 = 245 \times 12\% \approx 29$ and the expected number of ordinary orders $n_2 = 245 \times 88\% \approx 216$.

The expected weight and volume of urgent orders are $E\left[w_1\right]=48kg$, $E\left[v_1\right]=0.25m^3$, respectively. The expected weight and volume of ordinary orders are $E\left[w_2\right]=160kg$, $E\left[v_2\right]=0.84m^3$, respectively.

Take them into the random expected model,

$$\max\ d_1^+ - d_1^- - d_2^+ + d_2^-$$

$$s.t.\ \ 48\left\{3x_1 - 100\left(x_1 - a_1\right)\right\} + 160\left\{x_2 - \left(x_2 - a_2\right)\right\} - d_1^+ + d_1^- = 0$$

$$48\cdot 100\left(x_1 - a_1\right) + 160\left(x_2 - a_2\right) - d_2^+ + d_2^- = 0$$

$$48a_1 + 160a_2 \le 30000$$

$$0.25a_1 + 0.84a_2 \le 100$$

$$a_i - x_i \le 0$$

$$x_1 - 29 \le 0$$

$$x_2 - 216 \le 0$$

$$a_i, x_i, d_i^{\pm} \ge 0 \quad \textit{for all } i = 1,2$$

It can obtained that the maximal expected revenue is 17784, the minimal penalty cost is 0, the optimal solution is $x_1 = a_1 = 29$, $x_2 = a_2 = 85$, the initial approximate solution of the opportunity cost of loading weight and volume is $\pi_w = 1$, $\pi_v = 0$.

(2) Compute the unit prorated cargo rate of all kinds of goods.

$$pcr_{1w} = max\left\{0, r_1 - \pi_v\right\} = max\left\{0, 3-0\right\} = 3$$

$$pcr_{2w} = max\left\{0, r_2 - \pi_v\right\} = max\left\{0, 1-0\right\} = 1$$

$$pcr_{1v} = max\left\{0, r_1 - \pi_w\right\} = max\left\{0, 3-1\right\} = 2$$

$$pcr_{2v} = max\left\{0, r_2 - \pi_w\right\} = max\left\{0, 1-1\right\} = 0$$

(3) Take 10 minutes as a time interval *t*, then 48 hours will be divided into $T = 48\times 60 \div 10 = 288$ time intervals. Since the arrival process of urgent and ordinary follows the Poisson distribution during the whole period of booking cargo space, the probability of all arrival goods is same and we have

$$p_{1t} = 0.12\times\frac{245}{288} = 10.21\%$$

$$p_{2t} = 0.88\times\frac{245}{288} = 74.86\%$$

$$p_{0t} = 1 - \sum_{i=1,2} p_{it} = 14.93\%$$

for all t = 0,1,2,…T-1.

Take all data into equation (29)~(32), we get the dynamic programming model and further obtain the unit opportunity cost by solving them (See Table 1).

Table 1. Unit opportunity cost of the loading weight and volume (Only the first and second time interval)

Time interval	*Surplus weight*	*Expected revenue of weight*	*Marginal opportunity of weight*	*Surplus volume*	*Expected revenue of volume*	*Marginal opportunity of volume*
1	10	27.00	3.00	10	18.00	2.00
1	20	56.94	2.97	20	37.95	1.97
1	30	83.23	2.11	30	54.31	1.12
1	40	97.48	1.08	40	58.65	0.08
1	50	107.63	1.00	50	58.81	0.00
1	60	117.63	1.00	60	58.81	0.00
1	70	127.63	1.00	70	58.81	0.00
1	80	137.63	1.00	80	58.81	0.00
1	90	147.63	1.00	90	58.81	0.00
1	100	157.63	1.00	100	58.81	0.00
2	10	27.00	3.00	10	18.00	2.00
2	20	56.94	2.97	20	37.94	1.97
2	30	83.14	2.09	30	54.22	1.10
2	40	97.28	1.08	40	58.46	0.08
2	50	107.42	1.00	50	58.60	0.00
2	60	117.42	1.00	60	58.61	0.00
2	70	127.42	1.00	70	58.61	0.00
2	80	137.42	1.00	80	58.61	0.00
2	90	147.42	1.00	90	58.61	0.00
2	100	157.42	1.00	100	58.61	0.00
…	…	…	…	…	…	…

Further, the optimal strategy is listed in Table 2. If we use the traditional strategy, that is, first arrival is firstly received and transported, the average income is 16223.84 yuan, the average rate of loading weight is 99.96% and the average rate of loading volume is 79.72%. If we use the shipping space control strategy considering the priority of the goods, the average income is 17296.32 yuan, the average rates of loading weight and loading volume are 99.96% and 78.31%, respectively. It can be easily obtained from the results that during the peak period, adopting the shipping space control strategy indeed brings the growth of income for the airline. This strategy is efficient.

Table 2. Results using two different strategies

Item	*Average Income*	*Average Rate of Loading weight*	*Average Rate of Loading volume*
First come first go	16223.84	99.96%	79.72%
Shipping space control strategy	17296.32	99.79%	78.31%
Changing rate	6.67%	-0.17%	-1.76%

6. Conclusion

Since air cargo is mainly transported by freighter and passenger aircraft belly, and the passenger aircraft belly compartment assumed most of the transportation business. On the one hand the aircraft capacity is limited. On the other hand, market demand has significant uncertainty and volatility. Not only there are so many kinds of goods transported, and different goods have different transport requirements, but also the weight and volume of goods have a very large uncertainty. Therefore, how to management the cargo space during the sales time is one of the important issues about air cargo management decisions. This paper is studied the problem of the air cargo space management strategy with a comprehensive, abstract and simplified way, on the basis of the actual characteristics of transport demand in China's air cargo market. First it gives full focus on the urgent transportation of goods and general cargo transport whose time requirements are different. Then the effect of air cargo booking orders cancellation phenomenon is considered. As a result, a new model of air cargo space management for a single-leg flight is proposed and solved, based on the existing research. This study has certain reference value for the actual management of Air China Cargo, helping air cargo companies to make the right management decisions to enhance space utilization and profitability while also improving customer satisfaction.

This paper researched the air cargo inventory controlling strategy according to China's transport requirement of air freight market. Considering the priority of all kinds of goods, we converted the two-dimensional air cargo freight problem with single segment into a one-dimensional passenger transport problem with two segments. Then the dynamic programming decomposition proposed by Talluri and Ryzin was used to approximate the optimal solution [2]. Finally, a numerical example was tested to show that adopting the shipping space control strategy indeed brings the growth of income for the airline. This strategy is efficient during the peak period. In addition, through analysis of the numerical examples, this paper finds that the marginal capacity opportunity cost is changed regularly with the change in remaining space capacity, booking time, and the cancellation rates. And through its simulation results, not only the paper has verified the effectiveness of the new programs, but also it sums up how to own these effectiveness.

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