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Cost variance analysis in unit costs of materials and a random combination of automatic polling sorting line

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ABSTRACT

The Core business in distribution center is to sort orders, the efficiency of sorting will directly impact on the whole logistics distribution center. Random automatic sorting of unit material is a control method by commonly used, this article based on the actual demand for order picking under herein scale, put forward polling control as a innovative idea to sort unit of materials, and divide the sorting order of unit materials into large flow order picking and general picking, using the full service mechanism to control the order picking for the large flow, and using parallel door service limit mechanism to control the order picking for ordinary flow, thus establish the automated sorting facility model of completely - parallel threshold polling portfolio for entire polling sorting system, solve the related performance parameters, and then compare the cost of unit materials which are sorting by fully automatic random sorting line and a combination of automatic polling of completely - parallel threshold, give out the specific formula to calculate their cost of corresponding points, sorting efficiency and time, and combined with practical, make out numerical calculation and analysis.

Key-Words*:* Unit Material, Random Sorting, Sorting of Rolling, Comparative Analysis

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INTRODUCTION

With the rapid economic development, the sorting efficiency of logistics and distribution center is increasingly unable to meet the demands of growing customer from market. Take the E-commerce for example, the logistics and distribution center warehouse explosion will occur, logistics line break and a series of cases during holidays and dumped goods Taobao date, which has largely shown that the backward logistics has become a bottleneck for economic development of the logistics industry. How to develop a new type of efficient sorting operating system has become a hot research. This article proposes the innovative application of polling service theory, and develops new sorting equipments in order to meet the growing sorting needs under scale economies. Besides, this article does in-depth modeling analysis of random sorting combination and polling sorting one, makes comparative studies in the cost of two styles in using to sort orders, and draw meaningful guidance.

2 Research Related

Yanyan Wang[1]studied the optimization problems of a parallel automatic sorting system, which is significant to reduce the total time of sorting operations, save logistics costs and improve the service efficiency of distribution center. Wei Xiao [2]established a set of key indicators cigarette sorting system optimization for cigarette sorting system, proposed solving ideas of the " decoupling - Optimized Subsystem". Jing Li[3]in Shandong University had a in-depth analysis of the operating costs of cigarette automatic sorting system, proposed a method to optimize the configuration of the device based on the critical point unit cost. Yi-gong Zhang and Wu Yaohua [4]came up a new method to reduce the order picking time by compressing goods spacing for the automatic sorting system orders merging and sorting optimization problem. In order to improve the efficiency of sorting , Wu Yingying[5]envisaged a parallel picking strategy, proposed to split the order to reduce the delay time of the target, however, how to minimize the picking time of orders still depended on a further study.

This article centered on the random automatic combination sorting line and polling automatic one of unit material, each does the system modeling, and gives out the comparative cost study of unit materials, draw the appropriate conclusions.

3 One Kind of Unit Material Combinations Automatic Random Sorting Line

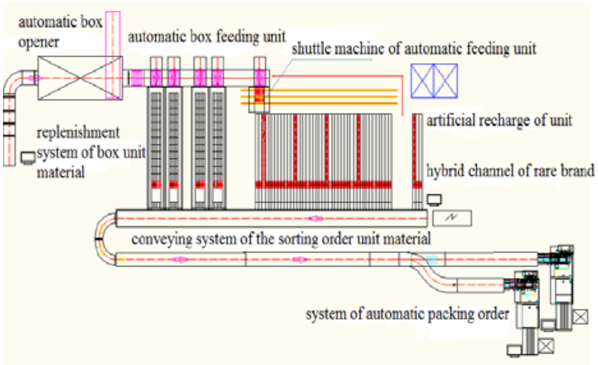

Figure1 One kind of unit material combinations automatic random sorting line model

Figure1 shows unit materials automated sorting line which has a high level, it can make it automated to open the box, replenish the goods, pick, pack and so on. In order to facilitate control, the sorting line equipment consisting of the large flow sorting machine and ordinary ones. In order to facilitate the transfer of cargo delivery, it requires each unit in the same brand in the packing material to be adjacent. Thus, each sorter work serially, throughput of order picking also the picking time is the sum of each role sorting time. Modeling and analysis are followed.

(1)Assumptions

In order to facilitate problem solving, we made the following assumptions based on the practical application:

①A variety of goods occupied and only one sorter; ②Different costs;③Operations of sorting have no waiting for replenishment ;④Sorting speed calculates at the average speed;⑤Facilities ability of sorting line is completely matched， and any ability to influence does not exist.

(2)The sorting time and picking efficiency of system orders

Article [5] gave out the analysis of order picking time in this model, sorting orders have a split time interval required between adjacent orders, and the interval of time between orders is equal to each interval of time multiplies by the quantity of orders minus one, the total time for the order picking is the sum of order picking time, intervals of time between orders can be calculated by the formula 1.

$$T_f = \sum_{i=1}^{n}[\delta_i\varphi_i/(\beta_{hd}\cdot h_d) + (1-\delta_i)\varphi_i/(\beta_p\cdot h_d)] + (Q-1)t_0/(3600\cdot h_d) \quad (1)$$

Among them, β_{hd}: Picking speed of the large flow sorting machine, unit/hour; n_1: Quantity of the large flow sorting machine; β_p: Picking speed of ordinary units, unit/hour; φ_i :Required orders of species i which has a large flow, unit; h_d : Hours of picking in a day, hour/day; t_0 : Intervals of time between orders, second/unit.

δ_i : The decision variables, when species i used the unit, $\delta_i = 1$; The unit is not used, $\delta_i = 0$.

Set $T_d = 1/(\beta_{hd}\cdot h_d)$、$T_p = 1/(\beta_p\cdot h_d)$ items as the unit picking time of the large flow sorting machine and ordinary units respectively.

$T_e = (Q-1)t_0/(3600\cdot h_d)$ is the intervals of time between orders, so the picking time is followed

$$T_f = (T_d - T_p)\sum_{i=1}^{n_1}\delta_i\varphi_i + T_p(Q - \sum_{i=1}^{n_1}\delta_i\varphi_i) + T_e \quad (2)$$

Efficiency of the random combination of automatic sorting line can be indirectly calculated by the quantity of total orders Q, so

$$O_f = Q / T_f \quad (3)$$

(3)Analysis of sorting cost

The sorting cost of unit time for the large flow sorting machine

$$C_d = (c_d + l_d c_s)(1+\alpha)/(y \cdot d_y) + f_d c_f + f_{de} c_{de} \quad (4)$$

Among them, C_d : The cost of a single large flow sorting machine per unit time, yuan; c_d : The cost of equipment for single large flow sorting machine, yuan/unit; l_d : The length of the large flow sorting machine conveyor, m/ unit; c_s : Cost of unit length of the conveyor, yuan/m; α : The cost of maintenance coefficient of equipment; y : The time of equipment depreciation, year; d_y : Workdays of equipment in a year, days/year; f_d : The occupied place of Single large flow sorting machine, square meters; c_f : Cost of the place occupied, yuan/square meters; f_{de} :The loss of single large flow sorting machine, consists of energy consumption, air consumption, material consumptions and ground loss, sets; c_{de} :The loss cost of single large flow sorting machine, yuan/set.

So the cost of single ordinary automatic sorting machine per unit time

$$C_p = (c_p + l_p c_s)(1+\alpha)/(y \cdot d_y) + f_p c_f + f_{pe} c_{pe} \quad (5)$$

Among them, C_p : The cost of single ordinary automatic sorting machine per unit time, yuan; c_p : The cost of equipment for single ordinary automatic sorting machine，yuan/set; l_p : The length of the ordinary automatic sorting machine conveyor, m/set; f_p : The occupied place of single ordinary automatic sorting machine, square meters; f_{pe} :The loss of single ordinary automatic sorting machine, consists of energy consumption, air consumption, material consumption and ground loss, sets; c_{pe} : The loss cost of single ordinary automatic sorting machine, yuan/set.

So the sorting cost of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section per unit time

$$C_b = (c_b + l_b c_s)(1+\alpha)/(y \cdot d_y) + f_b c_f + f_{be} c_{be} + r_g c_r \quad (6)$$

Among them, C_b :The sorting cost of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section per unit time, yuan; c_b : The cost of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section , yuan/set; l_b :The length of conveyor for the rear section, m/set; f_b :The occupied space of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section ,square meter; f_{be} :The loss of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section per unit time, consists of energy consumption, air consumption, material consumptions and ground loss, sets; c_{be} :The loss cost of transportation, coding , packaging, control systems, computer systems and other facilities for the rear section ,yuan/set; r_g : Number of person on the sorting line, person; c_r : The average wage per person, yuan/person.

Comprehensive above, the total cost of unit material combinations automatic random sorting line per unit time is followed

$$C_a = n_1[(c_d + l_d c_s)(1+\alpha)/(y \cdot d_y) + f_d c_f] + f_{de} c_{de} \sum_{i=1}^{n_1} \delta_i$$

$$+ n_2[(c_p + l_p c_s)(1+\alpha)/(y \cdot d_y) + f_p c_f] + f_{pe} c_{pe} \sum_{i=1}^{n_2} (1-\delta_i)$$

$$+(c_b + l_b c_s)(1+\alpha)/(y \cdot d_y) + f_b c_f + f_{be} c_{be} + r_g c_r \quad (7)$$

Among them, C_a: The total cost of unit material combinations automatic random sorting line per unit time, yuan; n_1: Numbers of the large flow sorter, set; n_2: Numbers of the ordinary sorter, set.

Set $C_d^* = (c_d + l_d c_s)(1+\alpha)/(y \cdot d_y) + f_d c_f$; $C_p^* = (c_p + l_p c_s)(1+\alpha)/(y \cdot d_y) + f_p c_f$, $C_{de}^* = f_{de} c_{de}$, $C_{pe}^* = f_{pe} c_{pe}$, then the formula (7) is changed like blow

$$C_a = n_1 C_d^* + n_2 C_p^* + C_b + (C_{de}^* - C_{pe}^*)\sum_{i=1}^{n_1}\delta_i + C_{pe}^*\sum_{i=1}^{n_2}\delta_i$$

$$= n_1 C_d^* + n_2 C_p^* + C_b + (C_{de}^* - C_{pe}^*)\sum_{i=1}^{n_1}\delta_i + n_2 C_{pe}^* \quad (8)$$

Obviously, C_d^*:the fixed costs of a single large flow sorter; C_{de}^*:the variable costs of large flow sorter; C_p^*:the fixed costs of ordinary sorter; C_{pe}^* :the variable costs of ordinary sorter .

So we've got the unit cost of unit material combination automatic random sorting line, and its optimization objective function F_a is followed

$$\min F_a = \frac{C_a T_f}{Q} = \frac{1}{Q}[n_1 C_d^* + n_2 C_p^* + (C_{de}^* - C_{pe}^*)\sum_{i=1}^{n_1}\delta_i + n_2 C_{pe}^* + C_b]$$

$$\times[(T_d - T_p)\sum_{i=1}^{n_1}\delta_i\varphi_i + T_p(Q - \sum_{i=1}^{n_1}\delta_i\varphi_i) + T_e] \quad (9)$$

4 Material Entirely – Limiting Parallel Combination of Automatic Door Polling Sorting Line

(1) A combination of automatic polling sorting line

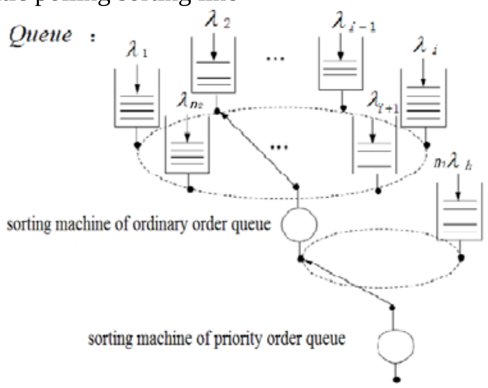

Figure 2 unit material entirely - a combination of automatic door polling sorting line

Change and adjust the unit material automatic random sorting line in Figure1, we get a new fully - parallel threshold priority control unit material combinations automatic polling sorting line, that means a combination of automatic polling material sorting line which is shown in Figure2. Similarly, the sorting system equipments are grouped into large flow sorters and ordinary ones, taking the relationship between efficiency and variety into account, take the priority order picking units as the implementation of full service control strategy, while the implementation of the general orders takes the gated service control unit strategy.

(2) Unit material fully - parallel threshold a combination of automatic sorting line polling model and parameters

Under the stability conditions of the system, that means under the conditions: $n_2\lambda\beta_p + n_1\lambda_h\beta_{hd} < 1$, we can obtain the probability generating function of the system state variables of the large flow sorter at t_{n^*}, such as formula 10

$$G_{ih}(z_1, z_2, \cdots, z_i, \cdots, z_{n_2}, z_h) = \lim_{n\to\infty} E(\prod_{j=1}^{n_2} z_j^{\xi_j(n^*)} \cdot z_h^{\xi_h(n^*)})$$

$$= R_i\left[\prod_{j=1}^{n_2} A_h(z_h)\right] G_i\left[z_1,\ z_2,\cdots,\ B_i\left(\prod_{j=1}^{n_2} A_j(z_j)A_h(z_h)\right),\ z_{i+1},\cdots,\ z_{n_2},\ z_h\right]$$

Among them,

$$i = 1,2,\cdots,\ n_2,\ j = 1,2,\cdots,\ n_2 \quad (10)$$

When the ordinary sorter pick orders by polling of $i+1$ at t_{n+1}, we can obtain the probability generating function of the system state variables which has been shown in formula 11

$$G_{i+1}(z_1,\ z_2,\cdots,\ z_i,\cdots,\ z_N,\ z_h) = \lim_{n\to\infty} E\left(\prod_{j=1}^{n_2} z_j^{\xi_j(n+1)} \cdot z_h^{\xi_h(n+1)}\right) = G_{ih}(z_1,\ z_2,\cdots,\ z_i,\ z_{n_2},\ B_h(\prod_{j=1}^{n_2} A_j(z_j)Q_h \prod_{j=1}^{n_2}(A_j(z_j))))$$

(11)

Among them, $i = 1,2,\cdots,\ n_2,\quad j = 1,2,\cdots,\ n_2$;

$$Q_h(z_h) = A_h(B_h(z_h Q_h(z_h)))\,;$$

$G_{ih}(z_h) = R_i(A_h(z_h))\{B_i(A_h(z_h))[1 - G_i(1,1,\cdots,0,\cdots,1,1)] + G_i(1,1,\cdots,0,\cdots,1,1)\}$ According to the content discussed above, we can get MQLOPO of the large flow sorter

$$g_{ih}(h) = \frac{r\lambda_h(1 - n_1\lambda_h\beta_{hd})}{1 - n_1\lambda_h\beta_{hd} - n_2(\lambda\beta_p - \lambda r)} \quad (12)$$

MQLOCO for orders queue of ordinary sorter

$$g_i(i) = \frac{n_2 r\lambda}{1 - n_1\lambda_h\beta_{hd} - n_2(\lambda\beta_p - \lambda r)} \quad (13)$$

MCP for orders queue of large flow sorter

$$T_C = \frac{n_2 r}{1 - n_1\lambda_h\beta_{hd} - n_2(\lambda\beta_p - \lambda r)} \quad (14)$$

ST of the unit material fully - parallel threshold Combination automatic polling sorting line, that means the ability of the system

$$O = n_2\lambda\beta_p + n_1\lambda_h\beta_{hd} \quad (15)$$

MWTOPO for orders queue of large flow sorter

$$E(w_h) = \frac{g_{ih}(h,\ h)}{2n_1\lambda_h g_{ih}(h)} + \frac{n_1\lambda_h B_h''(1)}{2(1 - n_1\lambda_h\beta_{hd})} - \frac{A_h''(1)}{2n_1^2\lambda_h^2(1 + n_1\lambda_h\beta_{hd})} \quad (16)$$

Among them, the second original pitch for the orders queue of large flow sorter is as follows

$$\begin{aligned} g_{ih}(h,\ h) =\ & n_1^2\lambda_h^2 R''(1) + rA_h''(1) + \frac{n_2\lambda r\left[2n_1^2\lambda_h^2\beta_p r + \beta_p A_h''(1) + n_1^2\lambda_h^2 B''(1)\right]}{1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r} \\ & + \frac{n_2 n_1^2\lambda_h^2\beta_p{}^2}{(1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)(1 + \lambda\beta_p - \lambda_h\beta_h)}\Big\{ r^2 R''(1) + A''(1) \\ & \times\left[\frac{r(\lambda\beta_p - n_1\lambda_h\beta_h\lambda\beta_p + \lambda^2\beta_h^2)}{(1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)} + r - n_1\lambda_h\beta_h\right] + \frac{r(n_2\lambda^3 + n_1^2\lambda^2\lambda_h^2)B''(1)}{(1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)} \\ & + (n_2 - 1)\lambda^2 r^2 + \frac{r\lambda^2}{(1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)}\left[n_2(n_2+1)\lambda\beta_p r - n_1(n_2 - 1)\lambda\beta_p\lambda_h\beta_h\right. \\ & \left. + (n_2 - 1)\lambda\beta_p - 2n_1^2\lambda_h^2\beta_h^2 + 2n_1\lambda_h\beta_h\right]\Big\} \end{aligned} \quad (17)$$

MWTOCO for the orders queue of the ordinary sorter

$$E(w_i) = \frac{(1 + \lambda\beta)g_i(i,\ i)}{2\lambda g_i(i)} \quad (18)$$

Among them, the second original pitch for the orders queue of large flow sorter is as follows

$$g_i(i,\ i) = \frac{n_2}{(1 - n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)(1 + \lambda\beta_p - \lambda_h\beta_h)}\Big\{ r^2 R''(1)$$

$$+\left[\frac{r(\lambda\beta_p - n_1\lambda_h\beta_h\lambda\beta_p + \lambda^2\beta_h^2)}{(1-n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)} + r - n_1\lambda_h\beta_h\right]A''(1) + \frac{r(n_2\lambda^3 + n_1^2\lambda^2\lambda_h^2)B''(1)}{(1-n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)}$$

$$+(n_2-1)\lambda^2 r^2 + \frac{r\lambda^2}{(1-n_1\lambda_h\beta_h - n_2\lambda\beta_p + n_2\lambda r)}\left[n_2(n_2+1)\lambda\beta_p r - n_1(n_2-1)\lambda\beta_p\lambda_h\beta_h + (n_2-1)\lambda\beta_p - 2n_1^2\lambda_h^2\beta_h^2 + 2n_1\lambda_h\beta_h\right]\Bigg\} \quad (19)$$

(3) The cost analysis of unit material fully - parallel threshold a combination of automatic polling sorting line

Use the cost analysis method of a combination of the aforementioned automatic random sorting line, we can obtain the sorting costs per unit of the unit fully - parallel threshold a combination of automatic polling sorting line:

$$C_{pol} = n_1 C_d^* + n_2 C_p^* + C_b + n_1 C_{de}^* + n_2 C_{pe}^* \quad (20)$$

Among them, C_d^*: The fixed costs of a single large flow sorter; C_{de}^*:The variable costs of large flow sorter; C_p^*: The fixed costs of ordinary sorter; C_{pe}^*: The variable costs of ordinary sorter.

Thus, you can get the optimization objective function of unit material fully - parallel threshold a combination of the automatic polling sorting line

$$\min F_{pol} = [n_1 C_d^* + n_2 C_p^* + C_b + n_1 C_{de}^* + n_2 C_{pe}^*]T_c \frac{1}{Q} + n_1 C_{de}^* E(w_h)\cdot\frac{\varphi}{Q}$$

$$+ n_2 C_{pe}^* E(w_i)\cdot\frac{(Q-\varphi)}{Q} \quad (21)$$

Among them, φ :The total sorting orders of large flow sorter response; Q :The number of total orders.

5 Examples of Application

A distribution center pick the sales order of the city, sorting equipment and personnel -related data has been shown in Table 1 , quantity of each variety of goods is shown in Table 2 , orders $e=10$ units, and the total amount of orders $Q=107$ box(Note : 1 box = 20 units) , so set $n_1=2$, $n_2=8$, sorting opportunities of 2 large flow sorters are equal, by using the full-service incentives, then the 8 ordinary sorters also has the equal opportunities, by using the mechanism of control threshold services. Identify which has lower costs between the two sorting control system.

Table 1 parameters of sorting equipment and personnel -related data

Symbol and data	Symbol and data	Symbol and data
c_d : 150000yuan/set	c_p : 20000yuan/ set	c_s : 3000yuan/m
c_f : 0.5yuan/ square meters /day	l_p : 0.5m/ set	l_d : 1.5m/set
f_d : 0.5 square meters/ set	f_{de} : 2sets	α : 20%
β_{hd} : 0.08unit/s	β_p : 0.4 unit/s	t_0 : 0.4s/unit
c_r : 100yuan/person/day	d_y : 250day/year	y : 15year
c_{de} : 48yuan/set/day	r_g : 4person	h_d : 8 hour /day
f_p : 0.2 square meters / set	f_{pe} : 8sets	e : 300unit
c_{pe} : 12yuan/set/day	c_{be} : 222yuan/unit	f_{be} : 1set
f_b : 40 square meters	c_b : 500000yuan	l_b : 22m

Table 2 quantity of each species of orders（under common case）(cell：unit）

Construction of orders	$E(w_h)$	$E(w_i)$	T_c
16（13，3）	0.0001465	2.8327	6.2375

21（17，4）	0.00040458	2.8641	6.1656
3（1，2）	0	2.8092	6.3221
9（3，6）	0	2.9041	6.0043
13（4，9）	0	3.0485	5.9671
1（0，1）	0	2.8264	6.4605
1（1，0）	0	0	6.6282
10（9，1）	0	2.8151	6.4743
15（8，7）	0	2.9508	5.9828
18（10，8）	0	2.9985	5.9750

According to the data in Table 1to Table 2, we can obtain:
$C_d^* = 49.69$ yuan/day/set; $C_p^* = 6.98$ yuan/day/set; $C_{de}^* = 48$ yuan/day; $C_{pe}^* = 12$ yuan/day; $c_b = 2821.12$ yuan/day; $T_d = 2.1701\times10^{-5}$ day/unit; $T_p = 8.6806\times10^{-5}$ day/unit; $T_e = 1.4722\times10^{-3}$ day/unit.

Using the parameters and ordering data above, we can calculate that when using 2sets of large flow sorter, 28sets of ordinary sorters under the random sorting, picking the orders ordinary of the table 4-2, the cost of unit materials for continuous random sorting is $\min C_a = 0.1822$ yuan/unit. While under polling control sorting, using same equipment, the cost of polling sorting controlled is $\min C_{pol} = 0.1265$ yuan/unit.

In order to further analysis the feature of different sorting line for unit material, the two tables following give out the total different orders, one couple is the case of all the priority is larger than the ordinary, and the other one is the case of all the priority is smaller than the ordinary one. Just as the following Table 3 and Table 4:

Table 3 orders under the case of all the priority is larger than the ordinary （cell: unit）

Construction of orders	$E(w_h)$	$E(w_i)$	T_c
12（10,2）	0.1466	5.1708	10.6468
11（9,2）	0.1050	5.0479	10.5042
13（10,3）	0.1566	5.3950	10.8480
12（11,1）	0.1931	5.1930	10.7625
15（11,4）	0.2434	5.9120	11.4052
15（10,5）	0.2482	6.3091	11.8213
11 (10,1)	0.1422	5.0484	10.6004
10 (9,1)	0.1056	4.9372	10.4606
7 (6,1)	0.0287	4.6828	10.1438
11 (11,0)	0.1957	0	10.8785

Table 4 orders under the case of all the priority is smaller than the ordinary（cell: unit）

Construction of orders	$E(w_h)$	$E(w_i)$	T_c
12（2, 10）	1.5716	17.8813	21.3839
11（2, 9）	0.9974	11.9643	16.9833
13（3, 10）	1.5781	18.0915	21.5425
12（1,11）	2.6903	33.3720	30.8060
15（4, 11）	2.7761	35.2009	31.9425
15（5, 10）	1.6338	18.8631	22.1142
11 (1,10)	1.5607	17.7667	21.2920
10 (1, 9)	0.9813	11.9229	16.9402
7 (1,6)	0.2117	6.2670	11.7168
11 (0, 11)	0	33.2957	30.7541

By calculating the orders from Table3, we can obtain $\min C_a = 0.2446$ yuan/unit, $\min C_{pol} = 0.1531$ yuan/unit.

By calculating the orders from Table4, we can obtain $\min C_a = 0.3205$ yuan/unit, $\min C_{pol} = 0.4961$ yuan/unit.

CONCLUSION

Combined with the data above, and also further analysis and study, we get the differences between two automatic sorting line which are as follows

(1)Unit material combinations automatic random sorting line model is a serial mode, and usually using sequential control, analyze the time of sorting order, but it did not touch on the formation mechanism of order sorting, and it has not been able to give the targeted tuning parameters for sorters. In the actual production, the control debugging of the sorting line often only relies on the experienced commissioning personnel.

(2) Using entirely - second parallel priority polling threshold control to establish the automatic polling sorting line combination model for unit material. First, the business definition of the sorting line orders is set to be the processes to achieve, sorting service process as well as the conversion process between operations, and each process is independent of each other ; Service rules is to serve the first one, which is namely of the FCFS; The arriving process of orders is set to be non- homogeneous Poisson process; Service process is a mutually independent random variable ; unit material of sorters will not stock, VC queue of orders is infinite to random huge variables. Secondly, using the two parallel priority control to manage orders, divide them into general orders and priority ones, the ones sorting the general order are grouped into ordinary units, with the parallel threshold control strategy ; The ones sorting the orders of priority are divided into large flow units, with the fully control strategy to establish the probability generating function, take system analysis to solve the appropriate system parameters.

(3)Under the two kind of control strategies, the cost of order picking is different, under certain conditions, the cost is lower and more fully to use the resources in polling sorting line. In accordance with control mechanism in random and polling respective, a combination of automated material handling capacity of unit lines can be calculated indirectly, its throughput capacity depends on the number of orders which are sorting machine at the same time. By using a fully - parallel threshold control strategy, throughput of the automatically polling sorting line model for unit materials can be found out directly, and it’s just the sum of the capacity of large flow sorting units and units of general sorting.

(4)A combination of automatic polling sorting line model for unit material is different from the one of random, it proposes a new control method, as well as comes up with a new way to develop the large- scale flow of automatic sorting machine under the condition of scale economy, provides more than enough space for innovation and imagination. Moreover, the new automatic polling sorting line can completely control the parallel sorting operations.

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