

Retraction

Retracted: E-Commerce Sorting Equipment and System Based on Cloud Computing

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] L. Chen, "E-Commerce Sorting Equipment and System Based on Cloud Computing," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 7947598, 9 pages, 2022.

Research Article

E-Commerce Sorting Equipment and System Based on Cloud Computing

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In order to solve the problems of order reduction and customer churn caused by sorting delays, the author proposes a method for e-commerce sorting equipment based on cloud computing. This method mainly adopts double-layer sorting equipment; compared with single-layer automatic sorting equipment, double-layer sorting equipment has the characteristics of higher efficiency and smaller floor space. The sorting method adopts the “group sorting” method, which can effectively improve the sorting efficiency of the sorting equipment. The algorithm method adopts the mathematical model based on cloud computing for calculation. *Experimental Results.* The author adopts the cloud computing-based “composition sorting” double-layer sorting equipment; compared with the traditional single-layer sorting equipment, the throughput of the single-layer sorting strategy is 0.72 pieces/s when the conveying speed of the conveyor belt is the same, the throughput of the two-layer same-direction strategy is 1.46 pieces/s, the throughput of the balanced load strategy is 1.97 pieces/s, and the throughput of the group sorting load strategy is 2.57 pieces/s. This method can effectively solve the problems of order reduction and customer churn caused by sorting delays.

1. Introduction

With the rapid development of e-commerce business, tens of millions of online merchants and e-commerce websites have emerged in our country; along with logistics providers who can provide them with high-quality logistics services, they are closely related to the development of modern e-commerce; in line with this, my country's logistics industry is facing both challenges and opportunities [1]. The challenge is that e-commerce requires fast and efficient distribution of modern logistics, which is more difficult for domestic logistics companies; in order to achieve rapid delivery of goods, it is necessary to start from both warehousing and distribution and use advanced management concepts and technologies in the warehousing link; equipment continues to improve the efficiency of goods out of the warehouse, and distribution requires logistics companies to increase distribution vehicles and make reasonable scheduling to achieve efficient operation of vehicles.

E-commerce is only a virtual economic process, and it still needs the transfer of the final commodity to realize the

whole economic process. Only through logistics and distribution, the real goods are actually transferred to consumers, and the entire e-commerce process is over [2]. In the entire circulation process, the logistics as a follow-up service provider of business flow, its efficiency has also become an important indicator for evaluating the satisfaction of e-commerce. Due to the slow sorting and the delayed delivery deadline, the customer's deduction is estimated to reach about 10,000 yuan, and the average monthly deduction accounts for about more than the output value, and the loss caused by this is huge. The direct loss reduces the profit of the enterprise, and the increase of the cost indirectly leads to the decrease of market customer satisfaction, the reduction of orders and the loss of customers, and the damage to the company's image.

In this environment, e-commerce starts from the sorting process, which greatly reduces the time delay due to sorting. Sorting operation refers to the process of taking out packages of a specific quantity and item from a designated storage location according to customer order requirements to meet customer needs. In recent years, due to the accelerated

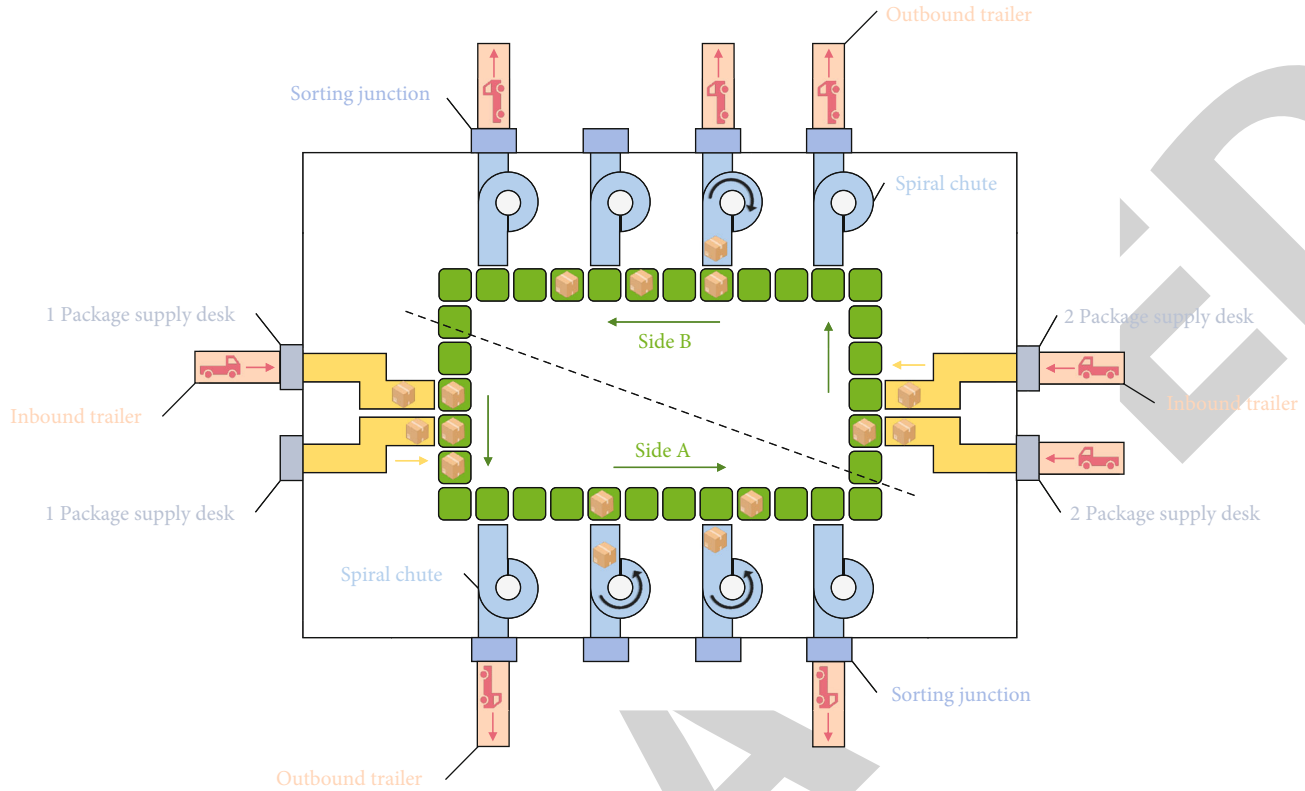


FIGURE 1: Top view of the upper cross-belt sorting line.

speed of product upgrading, the increasing requirements of manufacturing enterprises for “just-in-time,” and the rapid development of e-commerce, sorting orders are characterized by small batches, many varieties, short distribution cycles, and high precision requirements; the quality of the sorting operation greatly affects the efficiency of the distribution center, which puts forward higher requirements for the sorting operation [3]. The use of cloud computing in logistics and distribution can improve the overall informatization level of the industry with less cost, accelerate the IT transformation of the industry, and quickly respond to market changes.

2. Literature Review

E-commerce realizes the online business flow, information flow, and capital flow and completes the logistics process offline. As a service industry, e-commerce is now an important part of the economy of various countries and will play an increasingly important role. The level of its development has become an important indicator to measure the degree of economic development and modernization of a country. However, the research on e-commerce model in my country is still in the development stage. With the rapid development of the world economy, e-commerce, communication, and information technology, the traditional logistics distribution model is difficult to adapt to the development and needs of modern logistics distribution, and new distribution needs to continue to emerge, such as large-scale cross-regional distribution and joint distribution; business models have changed dramatically [4]. In particular, the emergence of

emerging technologies such as the Internet of Things technology and cloud computing technology has made the above-mentioned distribution needs to be met technically; a new distribution model urgently needs to emerge to solve the logistics distribution bottleneck problem in the e-commerce environment [5]. With the rapid development of the world economy, e-commerce, communication, and information technology, the traditional e-commerce model is difficult to adapt to the development and needs of modernization, and new needs continue to emerge. In particular, the emergence of emerging technologies such as Internet of Things technology and cloud computing technology has made the above-mentioned e-commerce distribution needs to be met technically; the emergence of new models can solve the sorting bottleneck problem in the e-commerce environment [6].

In this environment, the author proposes a method of sorting equipment for e-commerce based on cloud computing. Solve the delayed delivery time due to sorting in the e-commerce industry. In terms of sorting equipment, the author adopts double-layer sorting equipment; at present, domestic research mainly focuses on single-layer sorting equipment, while there are relatively few studies on double-layer sorting equipment and multilayer sorting equipment. Compared with single-layer automatic sorting equipment, double-layer sorting equipment has the characteristics of higher efficiency and smaller footprint. In terms of sorting methods, most of the existing literature considers the case that only one package is sorted by one pallet, and there are few studies that consider the case of “group sorting.” “Group sorting” means that in the sorting process, the scattered single parcels are combined

together according to certain rules, it has become a standardized and standardized method for sorting large sorting units, and the use of “group sorting” can effectively improve the sorting efficiency of sorting equipment. In order to further improve the sorting efficiency, based on the related research on double-layer sorting equipment, the author proposed the problem of destination assignment of double-layer sorting equipment considering group sorting, established a mathematical model, and designed a variable neighborhood tabu search algorithm to solve it; the experimental results verified the effectiveness and superiority of the algorithm [7].

3. Methods

3.1. Sorting Equipment Based on Cloud Computing. The author mainly uses double-layer cross-belt sorting equipment, the upper conveyor belt of the sorting equipment runs in a counterclockwise direction, and the lower conveyor belt runs in a clockwise direction [8]. The top view of the sorting equipment is shown in Figure 1. After the package enters the distribution center, the inbound trailer will deliver the package to the presorting platform. After the presorting process is completed, the parcels are transported to the parcel supply table in ascending order of number. Each package is sorted by a cross-belt tray. When the package is conveyed to the designated sorting bay, the cross-belt tray will unload the package, and the package will enter the material box from the spiral chute, ending the sorting of the package. When the package in the material box reaches a certain amount, the outbound trailer will load the package into the outbound truck for delivery. Before the next batch of packages arrives, each sorting device has completed the sorting of the current batch of packages.

The tray area of the cross-belt sorting equipment is fixed, and the tray area occupied by each package is mostly different, by considering “group sorting,” the tray utilization rate can be improved and the sorting time and the sorting distance can be shortened, in order to improve the sorting efficiency. In order to reduce the failure rate, this article uses two packages as a group to perform “group sorting.” For two packages to be “group sorted,” the two packages must meet the following conditions: (1) the destination is the same; (2) sorting is performed in the same batch; (3) the sorting is performed by the same conveyor belt; (4) the package supply operation is completed by the same package supply table; (5) the area of the pallet occupied by two parcels is smaller than that of a standard pallet. If two packages need to be “group sorted,” one of the packages has been presorted, and the other package has not been presorted; the presorted package must be placed in the temporary storage area until another package. When one package arrives at the supply table, the package in the temporary storage area is put into the tray where the other package is located, and the two packages are sent to the conveyor belt for “group sorting.” If a package cannot be “group sorted” with any other package, the package is sorted by a single pallet. Depending on the context of the problem and the definition of “group sorting,” the author studies the destination assignment problem of a two-level sorting equipment considering group sorting,

establishes a 0-1 planning model, weighs the load conditions of the upper and lower layers of the sorting equipment, and makes decisions on the premise of satisfying the equipment-related constraints and the optimal sorting and scheduling scheme of the batch of parcels [9, 10]. The symbols involved in the mathematical model and their meanings are as follows:

(1) Sets and subscripts

- D : The collection of destination numbers in a package
- K : The set of conveyor layers, the subscript is k
- M_A : The set of sorting bay numbers on the A side of the sorting equipment, the subscript is I
- M_B : The set of sorting bay numbers on the B side of the sorting equipment, the subscript is I
- E : Set of sorting bay numbers, $E = M_A \cup M_B$
- G_1 : Set of package numbers that enter the sorting equipment from the no. 1 package supply table, with subscripts i, j
- G_2 : The set of packet decay numbers entering the sorting equipment from the no. 2 packet supply table, the subscripts are i, j
- S : The set of numbers in the bag, $S = G_1 \cup G_2$.

(2) Parameters

- $t_{i,l,k}$: The sorting distance that the bag i is sorted from the k -layer conveyor belt and exited from the I sorting grid
- $d_{i,j}$: If the destination number of package i and j is the same, it is 0; otherwise, it is 1
- $p_{i,j}$: Packages i and j have the same sorting batch and destination number, and if the area of the tray occupied by the two parcels is less than the area of a standard tray, it is 1; otherwise, it is 0.

(3) Decision variables

- $x_{i,k}$ – 0 – 1 variable, if the package i is sorted from the k -level conveyor belt, it is 1; otherwise, it is 0
- $y_{i,l}$ – 0 – 1 variable, if the package i leaves the warehouse from the I sorting bay, it is 1; otherwise, it is 0
- $o_{i,j}$ – 0 – 1 variable, it is 1 if package i is not sorted from the same conveyor belt as package j ; otherwise, it is 0
- $r_{i,j}$: If the i in the package enters the tray where the package j ($j > i$) is located for “group sorting,” it is 1; otherwise, it is 0. If $i \geq j$, then $r_{i,j} = 0$; it means that the presorted bag later cannot enter the tray where the presorted jacket is located for “group sorting,” and each bag cannot be “group-sorted” with itself.

3.2. Mathematical Model.

$$\begin{aligned} & \text{Min} F(x_{i,k}, y_{i,l}, r_{i,j}) \\ & = \max_{k \in K} \left\{ \sum_{i \in S} \sum_{l \in E} t_{i,l,k} \left[\min \{x_{i,k}, y_{i,l}\} \right. \right. \\ & \quad \left. \left. - \min \left\{ x_{i,k}, y_{i,l}, \sum_{j \in S, j > i} r_{i,j} \right\} \right] \right\}, \end{aligned} \quad (1)$$

$$\text{s.t. } \sum_{k \in K} x_{i,k} = 1, \forall i \in S, \quad (2)$$

$$\sum_{l \in E} y_{i,l} = 1, \forall i \in S, \quad (3)$$

$$x_{i,1} - \sum_{l \in M_B} y_{i,l} = 0, \forall i \in G_1, \quad (4)$$

$$x_{i,0} - \sum_{l \in M_A} y_{i,l} = 0, \forall i \in G_1, \quad (5)$$

$$x_{i,1} - \sum_{l \in M_A} y_{i,l} = 0, \forall i \in G_2, \quad (6)$$

$$x_{i,0} - \sum_{l \in M_B} y_{i,l} = 0, \forall i \in G_2, \quad (7)$$

$$\sum_{j < i} r_{j,i} + \sum_{j > i} r_{i,j} \leq 1, \forall i \in S, \quad (8)$$

$$\sum_{l \in E} |y_{i,l} - y_{j,l}| = 2 * (1 - d_{i,j}), \forall i, j \in S, \quad (9)$$

$$\min_{k \in K} \{2 - x_{i,k} - x_{j,k}\} = 1 - o_{i,j}, \forall i, j \in S, \quad (10)$$

$$r_{i,j} \leq p_{i,j}, \forall i, j \in S, i < j, \quad (11)$$

$$r_{i,j} \leq o_{i,j}, \forall i, j \in S, i < j, \quad (12)$$

$$r_{i,j} \leq 1 - \sum_{h < i} r_{h,i}, \forall i, j, h \in S, i < j, \quad (13)$$

$$r_{i,j} \leq 1 - \sum_{h > i} r_{i,h}, \forall i, j, h \in S, i < j, \quad (14)$$

$$r_{i,j} \leq 1 - \sum_{h < j} r_{h,j}, \forall i, j, h \in S, i < j, \quad (15)$$

$$r_{i,j} \leq 1 - \sum_{h > j} r_{j,h}, \forall i, j, h \in S, i < j, \quad (16)$$

$$x_{i,k}, y_{i,l}, r_{i,j} \in \{0, 1\}, \forall i, j \in S, \forall l \in E, k \in K. \quad (17)$$

The objective function (1) represents the minimization of the total sorting distance of conveyor belts with larger conveying distances in double-deck sorting equipment. Among them, “ $\sum_{i \in S} \sum_{l \in E} t_{i,l,k} [\min \{x_{i,k}, y_{i,l}\} - \min \{x_{i,k}, y_{i,l}, \sum_{j \in S, j > i} r_{i,j}\}]$ ” represents the total sorting distance of the k th conveyor belt; “ $\max_{k \in K} \{\sum_{i \in S} \sum_{l \in E} t_{i,l,k} [\min \{x_{i,k}, y_{i,l}\} - \min \{x_{i,k}, y_{i,l}, \sum_{j \in S, j > i} r_{i,j}\}]\}$ ” means taking the maximum value from the total sorting distance of the two layers of conveyor belts. If there is “group sorting” ($\sum_{j \in S, j > i} r_{i,j} = 1$) between package $j (j > i)$ and package i , then the sorting distance of package i on these two conveyor belts is 0, and the sorting distance of bag j in the k th conveyor belt is $\sum_{l \in E} t_{j,l,k} * \min \{x_{j,k}, y_{j,l}\}$; otherwise, the sorting distance of bag i on the k th conveyor belt is $\sum_{l \in E} t_{i,l,k} * \min \{x_{i,k}, y_{i,l}\}$ [11].

Constraint (2) means that a package can only be sorted by one conveyor belt. Constraint (3) means that a package can only choose one sorting bay to exit the warehouse. Constraint (4) means that if the package enters the upper con-

veyor belt from the no. 1 package supply table, the package must exit the warehouse through the B-side sorting compartment. Constraint (5) means that if the package enters the lower conveyor belt from the no. 1 package supply table, the package must exit the warehouse through the a-side sorting compartment. Constraint (6) means that if the package enters the lower conveyor belt from the no. 2 package supply table, the package must exit the warehouse through the B-side sorting compartment. Constraint (7) means that if the package enters the upper conveyor belt from the no. 2 package supply table, the package must exit the warehouse through the a-side sorting compartment. Constraint (8) says that at most one “group sorting” is performed per package.

Constraint (9) means that the packages sent to the same destination are all exited from the same sorting compartment, and the packages sent to different destinations are exited from different sorting compartments. The formula “ $\sum_{l \in E} |y_{i,l} - y_{j,l}|$ ” is used to judge whether the sorting compartment selected by package i and j in the package is the same. If the sorting compartment selected by the two packages is the same, then $\sum_{l \in E} |y_{i,l} - y_{j,l}| = 0$; otherwise, $\sum_{l \in E} |y_{i,l} - y_{j,l}| = 2$.

Constraint (10) indicates whether two jackets are sorted by the same conveyor belt. The formula “ $\min_{k \in K} \{2 - x_{i,k} - x_{j,k}\}$ ” is used to judge whether the package i and the package j are sorted by the same layer of conveyor belt; if they are sorted by the same layer of conveyor belt, then $\min_{k \in K} \{2 - x_{i,k} - x_{j,k}\} = 0$; otherwise, it is 1.

Constraint (11) means that if two packages are to be “group sorted,” the following conditions must be met: the sorting batches of the two packages are the same, the destination numbers of the two packages are the same, and the area of the tray occupied by the two packages is less than the area of a standard pallet. Constraint (12) states that if “group sorting” is performed in two packages, the two packages need to be sorted by the same conveyor belt. Constraints (13) and (14) indicate that if package i is not “group sorted” with package $h (h \neq j)$, then package i and package $j (j > i)$ can be “group sorted.” Constraints (15) and (16) indicate that if bag j does not perform “group sorting” with package $h (h \neq i)$, then bag i and package $j (j > i)$ can perform “group sorting.” Constraint (17) states that $x_{i,k}, y_{i,l}, r_{i,j}$ and $o_{i,j}$ are 0-1 decision variables [12].

3.3. Data Experiment. The CPU of the experimental platform used by the author is IntelXeonE5-2680v42.4 Ghz, the memory is 256 GB, and the Windows764-bit processing system is used. The code is implemented in C#; the C# version is VisualStudio2012. Cplex uses version 12.6.1 [13].

3.4. Algorithm Testing. As shown in Table 1, the results of small-scale calculation examples are shown.

3.5. Algorithm Testing. This subsection compares the author’s proposed VNTS with the original TS (the original TS does not embed the VNS mechanism). It can be seen from Table 1 that, when the number of packages does not exceed 25, Cplex can obtain the optimal solution of the

TABLE 1: Results of small-scale examples.

Example size		C_{plex}		TS		VNTS			
$ S $	$ D $	$t_{C_{\text{plex}}} \text{ (s)}$	$F_{C_{\text{plex}}}$	$t_{\text{TS}} \text{ (s)}$	F_{TS}	$t_{\text{VNTS}} \text{ (s)}$	F_{VNTS}	$\Delta_{C_{\text{plex}}} \text{ (%)}$	$\Delta_{\text{TS}} \text{ (%)}$
15	8	56.11	12	0.16	12	0.23	12	0.00	0.00
15	8	29.54	11	0.10	11	0.13	11	0.00	0.00
15	10	277.74	12	0.06	12	0.21	12	0.00	0.00
15	10	386.29	11	0.11	11	0.26	11	0.00	0.00
20	8	87.02	13	0.17	13	0.31	13	0.00	0.00
20	8	454.32	18	0.12	18	0.28	18	0.00	0.00
20	10	1135.66	17	0.09	17	0.15	17	0.00	0.00
20	10	6221.36	14	0.03	14	0.07	14	0.00	0.00
25	8	4077.84	12	0.02	12	0.03	12	0.00	0.00
25	8	5784.96	12	0.03	12	0.05	12	0.00	0.00
25	10	—	—	0.03	17	0.04	17	—	0.00
25	10	—	—	0.02	15	0.12	15	—	0.00

Note: $|S|$ and $|D|$ represent the number of packages and the number of destinations of packages, respectively; $F_{C_{\text{plex}}}$, F_{VNTS} , and F_{TS} represent the optimal solutions obtained by C_{plex} , VNTS, and TS, respectively; $t_{C_{\text{plex}}}$, t_{VNTS} , and t_{TS} represent the average time-consuming of C_{plex} , VNTS, and TS calculations, respectively; $\Delta_{C_{\text{plex}}}$ and Δ_{TS} represent the relative errors between the results obtained by VNTS and those obtained by C_{plex} and TS, respectively, $\Delta_{C_{\text{plex}}} = F_{\text{VNTS}} - F_{C_{\text{plex}}}/F_{C_{\text{plex}}}$, $\Delta_{\text{TS}} = F_{\text{VNTS}} - F_{\text{TS}}/F_{\text{TS}}$.

TABLE 2: Results of large-scale examples.

Serial number	Example size		TS		VNTS		
	$ S $	$ D $	$t_{\text{TS}} \text{ (s)}$	F_{TS}	$t_{\text{VNTS}} \text{ (s)}$	F_{VNTS}	$\Delta_{\text{TS}} \text{ (%)}$
1	500	4	2.65	217	3.64	217	0.00
2	500	8	2.24	373	2.18	372	-0.02
3	500	12	1.88	511	3.99	511	0.00
4	500	16	3.07	664	4.39	664	0.00
5	700	4	5.35	306	7.79	305	-0.32
6	700	8	3.12	529	4.46	522	-1.32
7	700	12	2.78	744	3.75	726	-2.41
8	700	16	3.47	956	5.99	941	-1.56
9	900	4	5.49	408	8.44	391	-4.17
10	900	8	5.71	654	10.09	652	-0.30
11	900	12	6.28	953	17.53	953	0.00
12	900	16	7.91	1204	16.62	1195	-0.74
13	1000	4	4.35	437	22.82	437	0.00
14	1000	8	7.32	714	13.05	710	-0.56
15	1000	12	9.35	1022	19.01	1022	0.00
16	1000	16	10.79	1326	13.33	1326	0.00

Note: $|S|$ and $|D|$ represent the number of packages and the number of destinations of packages, respectively; F_{VNTS} and F_{TS} represent the optimal solution obtained by VNTS and TS, respectively; t_{VNTS} and t_{TS} represent the average time-consuming of VNTS and TS calculations, respectively; Δ_{TS} indicates the relative error between the results obtained by VNTS and those obtained by TS, $\Delta_{\text{TS}} = F_{\text{VNTS}} - F_{\text{TS}}/F_{\text{TS}}$.

model, but the solution time is very long, and VNTS and TS can obtain approximate optimal solutions or even optimal solutions in a shorter time. With the increase of the scale of the case, it is difficult for Cplex to solve the large-scale case, when the number of packages exceeds 25, Cplex can no longer obtain the optimal solution within 2 hours, while VNTS and TS can still be compared, in a short time, the approximate optimal solution, or even the optimal solution can be obtained.

It can be seen from Table 2 that in the large-scale calculation example, when the number of packages is 500 to 700 pieces, the solution time of TS is shorter than that of VNTS, but it is easy to fall into the local optimal solution, the quality of the obtained solution is poorer than that of VNTS; in contrast, VNTS can jump out of the local optimal solution and obtain a satisfactory solution that is closer to the global optimal solution. When the number of packages ranges from 900 to 1000, the quality gap of the solutions obtained

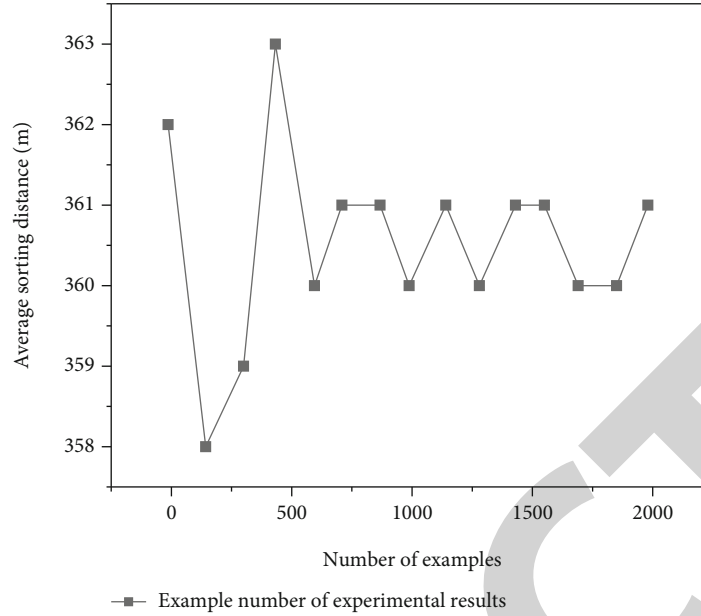


FIGURE 2: Experiment results of the number of examples.

between the two algorithms is more obvious, and the solution effect of VNTS is significantly better than that of TS; although the solution time of VNTS is longer than that of TS, VNTS can still obtain the optimal solution in a shorter time [14].

3.6. Effectiveness Experiment. Since the author generates examples in a random manner, it is necessary to conduct experiments on multiple different examples under the same scale and use the average of the experimental results as the author's research data [15]. Figure 2 is the experimental result of an experiment with a scale of 8 destinations and 500 parcels as an example. Among them, the area of the pallet occupied by each package and the destination number are subject to uniform distribution. As can be seen from Figure 2, when the number of generated examples of the same scale is less than 100, it has a greater impact on the mean value of the objective function value, for example, the mean value of the objective function value obtained by generating 5 examples is 362.6, the mean of the objective function values obtained by generating 10 examples is 357.91, while the mean of the objective function values obtained by generating 50 examples is 362.16, not yet converged. When the number of generated examples is greater than 100 and less than 1000, the mean value of the objective function value gradually converges; although there are fluctuations, the difference is not large. When the number of examples generated at the same scale is greater than or equal to 1000, the mean of the objective function values converges to 360.36. Therefore, 1000 examples are randomly generated for experiments of all scales.

4. Results and Discussion

4.1. Analysis of Sorting Efficiency. The double-layer sorting equipment studied by the author consists of two closed-

loop conveyor belts, 2 supply tables, 100 sorting grids, and 700 trays, and the standard area of one tray is 0.352 m^2 . Under normal circumstances, the operating speed of the sorting equipment is 2.7 m/s , and the equipment can adjust the operating speed according to the specific situation. The authors employed the following four strategies to study the effect of equipment selection, "group sorting," and DAP on sorting efficiency [16].

- (1) Single-layer sorting strategy: use single-layer sorting equipment for sorting, and the running direction of the sorting equipment is fixed
- (2) Double-layer same-direction strategy: use double-layer sorting equipment for sorting, and the conveyor belts on the upper and lower layers of the sorting equipment run in the same direction
- (3) Balance load strategy: use double-layer sorting equipment for sorting, and the running directions of the upper and lower conveyor belts of the sorting equipment are opposite
- (4) Group sorting load strategy: based on the balanced load strategy, the "group sorting" mode is introduced to improve the utilization of pallets

4.2. Efficiency Analysis of Double-Layer Sorting Equipment and "Group Sorting." As can be seen from Figure 3, when the conveying speed of the conveyor belt is the same, for example, when the conveyor belt speed is 2.7 m/s , the throughput of the single-layer sorting strategy is 0.72 pieces/s , the throughput of the double-layer same-direction strategy is 1.46 pieces/s , the load is balanced, the throughput of the strategy is 1.97 pieces/s , and the throughput of the group sorting load strategy is 2.57 pieces/s ; by comparing the balanced load strategy, the two-layer codirectional

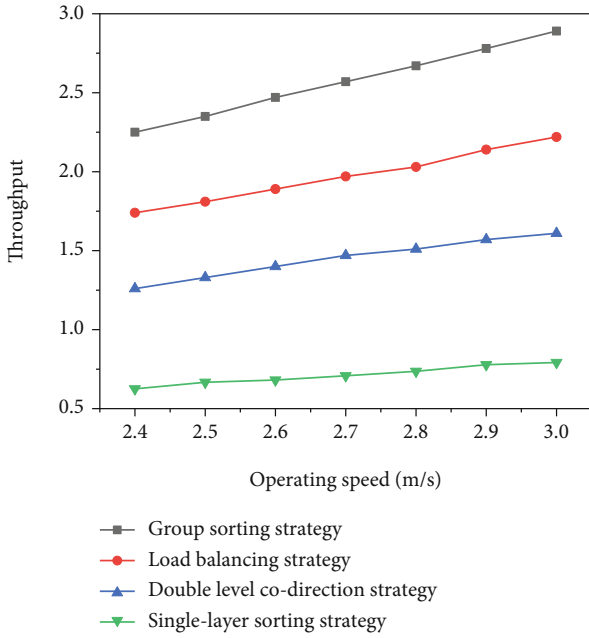


FIGURE 3: The effect of operating speed on throughput.

strategy, and the single-layer sorting strategy, it can be seen that the sorting efficiency of the double-layer sorting equipment is higher than that of the single-layer sorting equipment. By comparing the balanced load strategy with the double-layer same-direction strategy, it can be seen that when the conveying directions of the upper and lower conveyor belts are opposite, the sorting efficiency of the double-layer sorting equipment is higher; by comparing the group sorting load strategy with the balanced load strategy, it can be seen that “group sorting” can effectively improve the sorting efficiency of double-layer sorting equipment [17].

Figure 4 describes the impact of sorting strategy on throughput, when the number of destinations is the same, for example, when the number of destinations is 8, the throughput of the single-layer sorting strategy is 2.36 pieces/s, the throughput of the two-layer same-direction strategy is 4.82 pieces/s, the throughput of the balanced load strategy is 6.77 pieces/s, and the throughput of the group sorting load strategy is 8.55 pieces/s, compared with the single-layer sorting strategy, the balanced load strategy, and the double-layer codirectional strategy have higher throughput, that is, the sorting efficiency of the double-layer sorting equipment is higher than that of the single-layer sorting equipment; compared with the double-layer codirectional strategy, the throughput of the balanced load strategy is higher, that is, when the upper and lower conveyor belts of the double-layer sorting equipment run in opposite directions, the sorting efficiency is higher; compared with the balanced load strategy, the throughput of group sorting load strategy is higher, that is, “group sorting” can effectively improve the sorting efficiency of double-layer sorting equipment. It can be seen from the above experiments that, compared with single-layer sorting equipment, the sorting efficiency of double-layer sorting equipment is

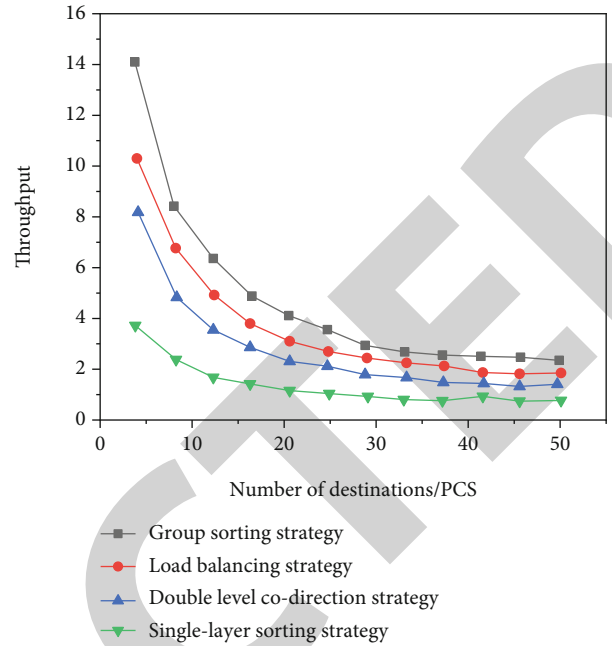


FIGURE 4: Impact of the number of destinations on throughput (considering DAP).

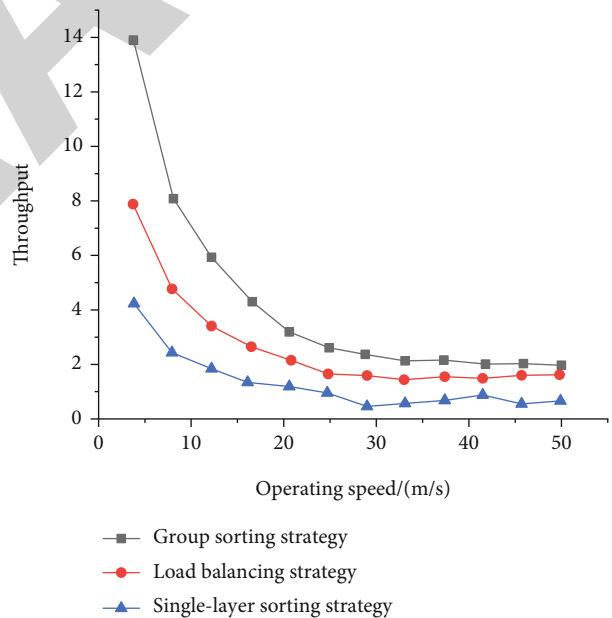


FIGURE 5: The impact of the number of destinations on throughput (without considering DAP).

higher; when the running directions of the upper and lower conveyor belts are opposite, the sorting efficiency of double-layer sorting equipment will be higher; “group sorting” can more effectively improve the sorting efficiency of double-layer sorting equipment [18, 19].

4.3. *Efficiency Analysis considering DAP.* Figures 4 and 5 describe the effect of the number of destinations on throughput when DAP is considered and DAP is not considered, respectively. From the experimental results, it can be seen

that, when the number of destinations is constant, the sorting and scheduling schemes considering DAP are better than those without DAP [20, 21]. For example, when the number of destinations is 16, it can be seen from Figure 4 that the throughputs of the single-layer sorting strategy, the balanced load strategy, and the group sorting load strategy are 1.28 pieces/s, 3.57 pieces/s, and 4.69 pieces/s, respectively; as can be seen from Figure 5, the throughputs of single-layer sorting strategy, balanced load strategy, and group sorting load strategy are 1.27 pieces/s, 2.53 pieces/s, and 3.77 pieces/s, respectively. The throughput of the sorting scheduling scheme considering DAP is 0.78%, 41.07%, and 24.41% higher than that of the sorting scheduling scheme without DAP, respectively. Compared with the sorting and scheduling scheme that does not consider DAP, the sorting and scheduling scheme that considers DAP can better match the package with the conveyor belt layer, the destination, and the sorting grid, thereby shortening the sorting distance and improving the sorting efficiency [22]. Therefore, the sorting scheduling scheme considering DAP is better than the sorting scheduling scheme without DAP [23].

5. Conclusion

The author proposes a method for e-commerce sorting equipment based on cloud computing, cloud computing combines the conditions of “group sorting” and the characteristics of double-layer sorting equipment, and the total sorting distance is minimized as the goal and effectively improve the sorting efficiency of sorting equipment. Combined with the “group sorting” strategy and using the search ability of cloud computing and fast algorithms to improve, it can generate a better sorting scheduling scheme in a short time and assist equipment operators in making decisions. Compared with single-layer sorting equipment, double-layer sorting equipment has the advantages of small footprint and high sorting efficiency. In addition, when using double-layer sorting equipment, it is recommended that the upper and lower conveyor belts run in opposite directions, in order to improve the sorting efficiency of double-layer sorting equipment. When using double-layer sorting equipment to sort parcels, it should be considered to carry out “group sorting,” which can effectively reduce the sorting distance of the sorting operation, thereby shortening the sorting time and improving the sorting efficiency. When formulating the sorting scheduling scheme, it should be considered that the sorting scheduling scheme of DAP can better match the package with the conveyor belt layer, the destination, and the sorting grid, thereby shortening the sorting distance and improving the sorting efficiency.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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