Optimization model design of cross-border e-commerce transportation path under the background of prevention and control of COVID-19 pneumonia

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Abstract
In order to better accelerate the transition from traditional trade to cross-border e-commerce, a cross-border e-commerce transportation route optimization model was designed in the context of the prevention and control of new crown pneumonia. Against the background of the new coronavirus pneumonia, through the analysis and research of the current situation of domestic and foreign e-commerce logistics, optimize the cross-border e-commerce logistics distribution model, establish an environmental model, and use efficient search algorithms to search for walking paths that meet environmental requirements. Based on the Dijkstra algorithm model of demand, and based on the linear relationship between demand and delivery distance, an optimal route selection model is established to select the optimal route with the shortest total travel distance. The simulation results show that the cross-border e-commerce transportation time of this model is within 13 h, which is shorter than that of the traditional model. The search efficiency of the optimal route for cross-border e-commerce transportation is higher, and the time for cross-border e-commerce transportation is shorter.

Keywords
COVID-19 pneumonia · Epidemic prevention and control · Cross-border e-commerce · Transport path

1 Introduction
In recent years, the development of cross-border electronic commerce has brought new opportunities to the export of China’s manufacturing industry. Although China’s exports continued to decline, cross-border electronic commerce’s exports went against the trend. Through cross-border electronic commerce, we can shorten the supply chain of manufactured goods export, reduce the export cost and enhance the export competitiveness of enterprises (Valarezo et al. 2019). Therefore, it is of great practical significance to study the export route optimization of manufactured goods under cross-border electronic commerce. Starting from cross-border electronic commerce, this paper combs the development status of cross-border electronic commerce, analyzes its relationship with manufactured goods export, and introduces the main problems faced by China’s manufactured goods export (Ji et al. 2019). Taking Viva office chair export as an example, this paper discusses the specific methods of optimizing the export route of China’s manufactured goods through cross-border electronic commerce, and analyzes how to realize the integration of cross-border electronic commerce’s supply chain through the integration of cross-border electronic commerce’s supply chain, the comprehensive foreign trade service platform and the optimization and upgrading of enterprises themselves, so as to promote the optimization of China’s manufactured goods export route and the development of China’s manufacturing industry. The combination of domestic e-commerce and traditional e-commerce can simply be understood as cross-border e-commerce, which has significant difference in expense, network, audience, level of complexity, operating excellence and benefit. Subject to the cross-border e-commerce transaction that belongs to wide range of causes, to enter a settlement through the e-commerce network, make payment settlement, and deliver resources through logistics and complete an import permit where conventional exchange uses information channels such as wholesale.

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2 Literature survey

Cross-border e-commerce transportation route optimization model under the background of COVID-19.

2.1 Cross-border e-commerce distribution model

Novel coronavirus pneumonia has run to affects the business model to enterprise, and many new businesses are seeking to explore and break through the new crown pneumonia background. Novel coronavirus pneumonia will be completely cancelled before the Chinese cross-border electricity suppliers will be more restricted, cross-border consumption will be difficult to meet, cross border consumer demand will be released, cross-border e-commerce will be rapid development. According to the development of the epidemic situation, the cross-border e-commerce platform should take measures to the sellers of the platform in a timely manner and formulate feasible response plans (Xu et al. 2018). Relying on the platform development, both sides can support each other. Good commercial development is a solid foundation for the development of the platform. We should make full use of the advantages of the platform, such as funds and resources, to create disaster resistance with enterprises. In the transformation of cross-border e-commerce, although the entire industrial chain of cross-border e-commerce has been impacted and affected, in the long run, China’s trade digitization process will accelerate. The logistics distribution process of e-commerce enterprises is various (Gao 2020). At present, the main domestic e-commerce enterprises and related departments have realized the importance of logistics distribution, and there are also some problems in logistics distribution. Based on the background of new coronavirus pneumonia, this paper analyzes and studies the current situation of domestic and foreign e-commerce logistics distribution, optimizes the cross-border e-commerce logistics distribution mode, realizes the logistics distribution function and provides perfect logistics services through the links of goods packaging, storage, processing, sorting, transportation, etc. Details are shown in Table 1.

The operation process of logistics center is based on logistics links and basic processes. For distribution centers with different functions and different commodity distribution, their operation processes and links will be different, but all of them are based on the basic processes and make appropriate adjustments to the corresponding operation links (Yuan et al. 2019). The main work includes: order processing, purchase, transportation, storage, sorting, distribution processing, sub-packing, delivery, etc. (Zhong et al. 2019). Figure 1 shows the basic operation process of the logistics center, shows the distribution process of the entire logistics center, and reflects the operation process of the entire logistics center.

As shown in the figure, the distribution center, like other economic entities, has clear business objectives and service targets, and its business activities are driven by customer order information (Liang and Wang 2019).

Many cross-border e-commerce organizations can come together to create a logistics warehouse storage center in local and overseas, and collaboration participants can distribute the goods to the distribution center and distribution center. As per the guidelines, after international buyers position the order, the logistics center transfers the commodities to the distribution center overseas. And then the fulfillment center, overseas distributes the products to overseas customers according to the shipment instructions. Therefore, during the planning and construction of distribution center, before carrying out distribution activities, it is necessary to analyze the data such as customer distribution, commodity characteristics, variety quantity and delivery time, and determine the types, specifications, quantity and delivery time of required commodities according to the order information. Order processing is the premise and foundation of distribution center organization and scheduling, and it is the core of the whole system (Bhattacharya and Raju 2019). In order to make better use of the capacity and loading capacity of loaders and improve the transportation efficiency, goods from different customers can be transported by the same truck. Therefore, all transportation work must be completed before shipment (Luo et al. 2019). Efficient mixing and assembly can not only reduce transportation costs, but also reduce traffic flow, change traffic conditions, and reduce operation time and operation costs. Only by selecting materials can we get twice the result with half the effort.

2.2 Cross-border e-commerce transportation route search

By establishing an environment model and using an efficient search algorithm, a walking path that meets the requirements of the environment is searched to achieve the goal of optimizing the objective function. Users are selective and pickier on what they expect from things and the internet. In addition, fantastic interfaces and innovations are just the first component of a meta search solution for eCommerce. Before making any decision, suggest evaluating the situation where data helps a great deal. Enormous continued business and significant technological advances have brought about, for better or worse, not only drastic improvements in the economic system, but also
widespread environmental consequences. The Internet offers a new age in which global players in the growth of e-commerce have increased. However, due to the limitations of the algorithm, the walking path obtained by path search is not necessarily a feasible path, and smoothing is needed before obtaining a feasible path (Chen et al. 2019). Under the objective existence of shelving in logistics distribution center, the optimization of commodity selection path has become a special important problem that restricts commodity selection. Mineral processing routes are usually horizontal and vertical straight lines. If the goods on two adjacent shelves are not on the same shelf, it is impossible to carry out coal preparation directly through one shelf, but must come out from the existing shelf and then operate on the other shelf (Mertens et al. 2020). Therefore, the smooth connection of paths is the key to optimize the procurement business path of e-commerce distribution center. On the basis of the model hypothesis, the mathematical model of batch ordering problem is established by using the following formula:

$$\max Z = r \sum_{s \in S} d_s x_s$$

$$\text{max} \ Z = r \sum_{s \in S} d_s x_s$$  \hfill (1)

In the objective function, $z$ represents the total similarity of one batch after another, $d$ represents the set of batches after one batch, $s$ represents the value of decision variable, which is 0 or 1, $X_s$ represents a selected batch, and $r$ represents the selection and batch of a path. The specific algorithm is as follows:

$$\text{S.T} : \sum_{i=1}^{k} v_t a_{ts} \leq V$$

$$\text{S.T} : \sum_{i=1}^{k} v_t a_{ts} \leq V$$  \hfill (2)

For the alternative path with volume constraint, $v_t$ is the quantity of volume in $t$ order, and ATS is a determining variable with a value of 0 or 1. When ats = 0, it indicates that the order $t$ has not been allocated to the $s$ batch; when ats = 1, it indicates that the order $t$ has been allocated to the $s$ batch; in V, the valid value for TV path transportation is:

$$\max \ S.T : \sum_{i=1}^{k} v_t a_{ts} = Z \sum_{s \in S} a_{ts} x$$

$$\max \ S.T : \sum_{i=1}^{k} v_t a_{ts} = Z \sum_{s \in S} a_{ts} x$$  \hfill (3)

The above formula means that each order can only be selected and assigned to one batch. Assuming that there are $x$ distribution nodes (cargo destinations) and $Y$ distribution centers (warehouses) in the network, and the node location remains unchanged, the nodes should be changed.

Table 1 Cross-border e-commerce distribution mode under the background of prevention and control of COVID-19 pneumonia

| Distribution mode | Form | Characteristic |
|-------------------|------|---------------|
| Provide home delivery service | Online transaction payment of goods directly delivered to the user’s home | It brings convenience to online shopping customers, improves service quality, and brings users a good online shopping experience. However, there are also corresponding disadvantages. When delivering goods to the door, customers need to provide detailed receiving address, which may cause the leakage of personal information of online shopping customers, which poses a great challenge to the security and confidentiality mechanism of e-commerce system. |
| Self service delivery | | |
| Manual self-service pick up point | One is that logistics suppliers set up special pick-up points through self-construction, and the other is to cooperate with local stores to set up pick-up points, such as shops, pharmacies, community properties, etc. | The cost of self-built mode is high, but the service is more professional. The cost of cooperation with stores is lower, and the service is more convenient. |
| Self service delivery cabinet | It is divided into public storage box and private receiving box. For example, Jingdong’s pick-up container, Walmart store’s locker, CoDeSys’s skybox | The cost of self-service delivery is lower, the information security of customers is high, and the time for customers to pick up goods is more flexible. |

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according to customer demand. When goods are allocated from distribution center \( m \) to node \( n \), the following conditions must be met. Limiting factors:

\[
V \leq V_{\text{max}} \leq T \leq T_{\text{max}}
\]  \hspace{1cm} (4)

In the equation, \( t \) is the conveying capacity and \( V \) is the speed of the conveying line. Then, the adjacency matrix \( A = a_{ij} \) is used to describe the transportation network, \( G = (X, Y) \), where \( a_{ij} = 0 \) indicates that there is no direct distribution path between distribution center and distribution node \( n \); \( A_{ij} = 1 \) indicates that there is no direct distribution path between distribution center \( M \) and \( N \). The adjacency matrix \( a \) is as follows:
Based on the above algorithm, this paper analyzes the alternative path of cross-border e-commerce, and selects the optimal route and alternative path of goods transportation based on the cost analysis principle.

### 3 Optimal route selection model of cross-border e-commerce transportation

According to the basic situation of China’s e-commerce logistics distribution, combined with the characteristics of express enterprises, this paper puts forward an effective e-commerce logistics distribution mode which is of great significance to improve the flexibility of the delivery volume of express enterprises, reduce the waiting time, and improve the quality and efficiency of express service. On the basis of the collected data, the regional geographic information is abstracted, and the key points are extracted by PS software to generate a simplified map (Panos and Densig 2009). Because of the complexity of geographical coordinate, the relative position information of each distribution point is expressed by self-built coordinate system. Each delivery point is numbered. Map and field measurement of the distance between each shipping point, and considering the waiting time (expressed by the product of average loading volume and waiting time) (converting waiting time into route length), the basic situation of logistics distribution route selection is shown in Table 2.

On the one hand, we should consider the characteristics of different groups and choose the corresponding distribution mode; on the other hand, we should also consider the customer satisfaction and cost (Saez et al. 2019). Setting the selection time window and automatically changing the delivery mode can reduce the uncertainty of waiting time, reduce the risk of failure, and realize the quantification of express waiting time. The method is based on the configuration of two-point solution. The C-W algorithm is a distributed algorithm that meets the requirements of actual distribution scenarios for customer randomness and complexities, as well as vehicle mileage constraints. It decreases the cost of delivery and helps to increase the amount of clients serviced and decrease the total waiting period for customers. The C-W algorithm is widely accepted by experts and scholars. In order to delay the possible channel conflict and make the dual channel supply chain in a coordinated state, manufacturers promise to increase a certain number of direct sales channels as compensation, and encourage dealers to continue to cooperate with dealers. At the same time, in order to ensure their own interests will not be damaged, the manufacturer can charge the distributor royalty as the threshold to obtain compensation (Peng et al. 2020).

**The matrix A above simply describes the relationship between the distribution nodes and the distribution center. Therefore, in order to search for the path that meets the environmental requirements more quickly, we need to use the Wij weighting method to describe it.**

\[
A = \begin{pmatrix}
0 & 1 & 1 & 0 & 1 & 1 \\
1 & 0 & 1 & 0 & 1 & 1 \\
0 & 1 & 0 & 0 & 1 & 1 \\
1 & 0 & 1 & 1 & 0 & 0 \\
0 & 1 & 0 & 0 & 1 & 1 \\
0 & 1 & 1 & 0 & 1 & 1
\end{pmatrix}
\]

(5)

The weighted matrix of the model is obtained.

\[
w_{ij} = \begin{cases}
w_{ij} & a_{ij} = 1 \\
0, & i = j \\
\infty, & a_{ij} = 0
\end{cases}
\]

\[
The weighted matrix of the model is obtained.
\]

\[
W' = \begin{pmatrix}
0 & \infty & 1(1) & 1(1) & 1(1) & \infty \\
\infty & 0 & 1(2) & \infty & 1(2) & 1(2) \\
1(1) & 1(2) & 0 & 1(1) & 1(2) & 1(2) \\
1(1) & \infty & 1(1) & 0 & 1(1) & \infty \\
1(11) & 1(2) & 1(2) & 1(1) & 0 & 1(2) \\
1(1) & \infty & 1(2) & 1(2) & \infty & 1(2) & 0
\end{pmatrix}
\]

(7)

Establish a further link between demand and distribution distance. Because the closer to the distribution center, the greater the demand of the distribution node for goods, so we can see the linear relationship between demand and distribution distance, such as the following formula:

\[
f(x) = \frac{\sqrt{2(E - W')}}{ZA \sum_{i} a_{ij} x}
\]

(8)

To measure the similarity between measurements, the shortest point distance process. In general, the sum of absolute differences between objects across all parameters often looks like two sample points that we will use to measure the various distance measure. GP and GQ are the expansion subgraphs rooted at the centroid vertices to optimize the shortest path. The shortest point distance method describes the distance between GP and two objects closest to GQ as the distance, such as the following formula:

\[
D(p, q) = \min \{d_{j \mid j \in G_p, l \in G_q}\}
\]

(9)

The maximum distance method regards the distance between GP and the farthest and nearest GQ as the distance between the two types. Therefore, the expression of searching cross-border e-commerce transportation path is as follows:

\[
B(p, q) = \max \{d_{j \mid j \in G_p, l \in G_q}\}
\]

(10)
the dominant position of producers in the second stage game

\[ p^*_2 = \theta[D(p, q) + B(p, q)] + f(x) \quad (11) \]

On this basis, the Dijkstra algorithm model based on demand is further established. According to the linear relationship between demand and distribution distance, the optimal path selection model is established:

\[ \theta = \sum f(x) \cdot w_{ij} \quad (12) \]

Based on the analysis of the comprehensive distribution mode of e-commerce logistics terminal, this paper proposes a new type of comprehensive distribution mode of logistics terminal, which can meet the needs of different groups while taking into account customer satisfaction and cost. By setting and selecting time window, and automatically changing the distribution mode, it can reduce the risk of courier waiting and distribution failure, and optimize the logistics terminal distribution path. Create a good research environment, so that the path optimization research has more practical significance (Hao and Li 2020).

According to the goal of customer demand planning, the revenue of meeting customer delivery time and supplier resources is calculated. There may be options such as positioning e-commerce DCs especially near parcel distributor centers, to use a third party for distribution or, on the other hand, bringing back in-house shipment, measuring the trade-offs by using distinct or combined e-commerce distribution centers. Decisions must be taken on the basis of the option of vendors, the place of warehouses, the distribution of operations, etc. On the basis of meeting customer delivery time, supplier resource income and network load balance, the scheduling function is realized. Initialization, that is to process all the best distance estimation except the source point. Combined with the distributed iterative method, it relaxes each edge several times in the edge set E, so that the best distance estimation of each small vertex v is close to the optimal distance. Whether the two endpoints of each edge of edge set E converge is analyzed. When all the vertices converge, the algorithm is correct and keeps the distance, which indicates that the distance is the best. Otherwise, the algorithm is wrong and the distance is not the best. On this basis, a dynamic optimization path algorithm is designed. Since the pricing strategy under the new business distribution strategy is the same as that under the centralized decision-making, the total profit of the dual channel supply chain is equal to the total profit under the centralized decision-making. It is, the dual channel supply chain has reached a coordinated state. The new algorithm investigates the changes of road conditions between the source point and the selected point as well as between the selected point and the target point. The optimal distance from the next point to the target point is regarded as the heuristic step of the selection. Select the least one from the sum of the actual time spent from all the starting points to the candidate points and the evaluation time from the candidate points to the target points, then the corresponding candidate points are the current points, and continue to consider the next starting node until it is selected. According to the above method, the final result is the traffic optimal path, and the optimal path with the shortest total travel distance is obtained by auxiliary selection. Based on this, the framework of the optimal selection model of e-commerce transportation route is optimized, as shown in the following Fig. 2.

### 4 Analysis of experimental results

In order to verify the actual effect of the new coronavirus cross-border e-commerce transportation route optimization model designed in this paper, it is compared with traditional methods, and the experimental results are analyzed. In order to ensure the uniform setting of experimental environment and parameters, the experimental program is written in Java language on Java virtual machine. The hardware environment for running this experiment is a GBIntelCorei5-2430M CPU running memory 5. The specific test parameters are shown in Table 3.

Through the correctness test and coverage detection experiment, the efficiency of the detection system is
verified. Coverage detection experiment refers to the proportion of total access paths detected by the two systems, while accurate testing refers to the proportion of the best recommended access paths. Experiments were carried out on the Windows NT platform using JAVA language, and the detection system designed in this paper was compared with the detection system designed with the clustering algorithm and the association rule algorithm. The optimal path search efficiency of different detection systems was compared respectively. Optimal path search effectiveness is presented with the support of the ideas of dynamical system searching and complex cut section in artificial intelligence as an analytical optimal route algorithm. The smart algorithm can optimize the search path, decrease the distance of the search, increase the rate of the search, that can be used in multi-graphs to solve the shortest route. In fact, the space vector review process is a dynamic method for generating a system tree whose time intensity is mainly associated to the state tree’s computing condition, and the lower the tree branch, the less time complexity. The test results are shown in Fig. 3.

Through novel coronavirus pneumonia, the paper finds that the efficiency of searching for cross border electricity supplier transportation path optimization is better than that

Table 3  Experimental parameters

| Project                           | Parameter                     |
|----------------------------------|-------------------------------|
| Operating platform               | Windows NT                   |
| Number of CPU cores              | 6 cores                      |
| Maximum capacity of detection system | 16 GB                     |
| Internal structure               | X86                           |
| Video card capacity              | 8 GB                          |
| Hard disk type                   | Solid state drive             |
| Interface connection mode        | CAN Bus serial                |
of the new crown pneumonia. In practice, the search efficiency is much higher. This method can detect multiple transmission paths in a short time and accurately select the optimal path, thus proving the road established in this paper. The diameter optimization model has strong performance and is worth popularizing.

Novel coronavirus pneumonia is used to further verify the effectiveness of the model. The cross-boundary e-commerce efficiency of the model and the traditional model is compared and analyzed, as shown in Fig. 4.

According to Fig. 4, the cross-border e-commerce transportation time of this model is within 13 h, which is shorter than that of the traditional model, which shows that using this model can improve the efficiency of cross-border e-commerce transportation.

5 Conclusion

Since the outbreak of novel coronavirus pneumonia, cross-border e-commerce has played an important role in the global procurement and transportation of goods. It needs cross-border support and cooperation of cross-border logistics enterprises to promote cross-border e-commerce. It is reported that cross-border logistics has played an important role in promoting the development of cross-border e-commerce. As mentioned at the beginning of this paper, the cross-border import supply chain is behind the cross-border procurement and transportation of a large number of anti-epidemic protective articles. The novel
coronavirus pneumonia will enable the global goods to supply rapidly and commercialization. In order to meet the market demand, we will design the cross-border e-commerce transportation path optimization model against the background of new crown pneumonia, so as to promote the development of the modern e-commerce industry.

This research seen as a starting point for Optimization Model Design of Cross-border E-commerce Transportation Path to produce more research and still need to improve logistic distribution towards relation between third parties, visibility and control of process and its service level in further research.

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Declarations

Conflict of interest The authors declare that they have conflict of interest.

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