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Overseas Warehouse Deployment for Cross-Border E-Commerce in the Context of the Belt and Road Initiative

Chanjuan Liu [1,*], Jinran Wu [2] and Harshanie Lakshika Jayetileke [3]

[1] School of Business Administration and Customs Affairs, Shanghai Customs College, Shanghai 201204, China
[2] School of Mathematical Sciences, Faculty of Science, Queensland University of Technology, Brisbane, QLD 4001, Australia
[3] Department of Mathematics, Faculty of Science, University of Ruhuna, Matara 81000, Sri Lanka
* Correspondence: liuchanjuan@shcc.edu.cn

Abstract: The development of cross-border e-commerce is generally faced with problems such as high freight, long transportation time, and low service level. However, overseas warehouses can effectively solve the above problems to a certain extent, and they can improve consumer satisfaction. Therefore, this paper proposed a method combined with the entropy technique for order of preference by similarity to ideal solution (E-TOPSIS) model and complex network analysis theory to make a comprehensive determination of overseas warehouse locations for China's e-commerce exports in the context of the Belt and Road Initiative (B&R). We selected 62 countries along the B&R as pre-candidates for overseas warehouse locations and then evaluated the significance of each node in cross-border e-commerce for Chinese export products. Finally, 15 countries were identified as the optimal overseas warehouse locations for Chinese export products along the B&R. The results can provide reference for overseas warehouse deployment of Chinese cross-border e-commerce enterprises as well as the development and the construction of the B&R.

Keywords: cross-border e-commerce; overseas warehouse deployment; the Belt and Road Initiative; E-TOPSIS; network centrality

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1. Introduction

The aim of this study is to investigate the determination factors of overseas warehouses for cross-border e-commerce and to find optimal overseas warehouse locations for Chinese export products along the Belt and Road (B&R). More specifically, we attempt to combine the entropy technique for order of preference by similarity to ideal solution (E-TOPSIS) model and complex network analysis theory to make a comprehensive determination of overseas warehouse locations not just considering the logistics transportation costs. In doing so, we attempt to solve problems of cross-border e-commerce, such as high transportation time and cost, therefore, promoting the development of China's cross-border e-commerce exports and the construction of the B&R.

According to the statistics, Chinese enterprises made direct investments in 49 countries along the BRI in 2015, with the investment increasing by 18.2% over the same period in 2014 [1]. China's increasing investment and cooperation with countries along the line have sufficiently promoted international trade, specifically the development of cross-border e-commerce and therefore cross-border logistics demand. Nevertheless, few studies have focused on cross-border logistics, especially relating to overseas warehouses.

The success of a cross-border e-commerce enterprise strongly correlates with its logistical performance and distribution systems [2]. The traditional cross-border e-commerce logistics models mainly refer to international postal parcels, international express delivery, and cross-border third-party logistics, which spend much time on transportation and have a high cost [3]. However, the rapid development of cross-border e-commerce in recent years has placed higher demands on cross-border logistics, and cross-border e-commerce enterprises in China lack professional logistics operations. Recently, some cross-border e-commerce platforms and export enterprises explored and configured overseas logistics distribution systems through an "overseas warehouse" to reduce the obstacles of geographical space and timeliness.

The basic principle of overseas warehouse operations is to establish warehouses in other countries or regions other than the seller's own country [4]. Figure 1 presents the logistics operation process of overseas warehouses in cross-border e-commerce. In the domestic segment, the merchant transports the goods to the domestic ports through domestic transit warehouses and then transports them to foreign ports by land, sea, or air. In the foreign segment, the merchant stores goods in overseas warehouses in advance. After receiving the customer's order, the overseas warehouse finishes the local distribution as quickly as possible. Due to the significant role of overseas warehouses in promoting the development of cross-border e-commerce and foreign trade, the Chinese government pointed out that a number of overseas warehouses for export products should be built to expand cross-border e-commerce and to support the development of Chinese export enterprises [5].

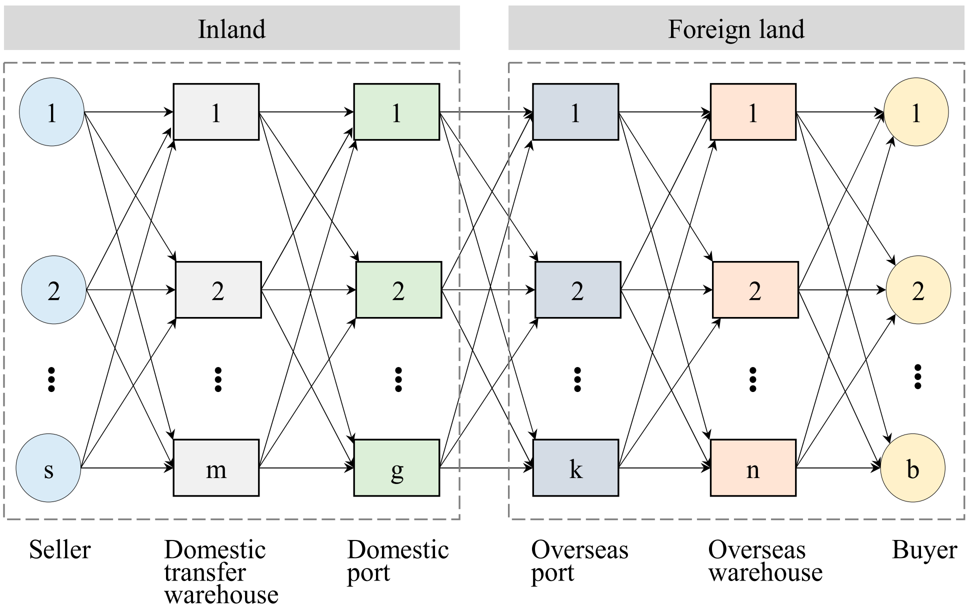

Figure 1. Logistics operation process of overseas warehouse for cross-border e-commerce.

Against this background, in the present study we attempt to investigate the optimal overseas warehouse locations for Chinese export products. Although the existing literature on logistics warehouse locations is vast, to our knowledge, this is one of the first systematic attempts to investigate overseas warehouses deployment for cross-border e-commerce for Chinese export products, notwithstanding its significance in the global economy and global supply chain. In doing so, this paper offers two main contributions to the existing literature. First, in this study, a method combined with the E-TOPSIS model and complex network centrality is proposed, which is an extension of the existing E-TOPSIS model. Second, the study of overseas warehouse location deployment for Chinese export products can provide a reference for export e-commerce sellers who have overseas warehouse demand.

The remainder of the paper is organized as follows: Section 2 reviews the related literatures about cross-border logistics, overseas warehouses, and logistics warehouse location deployment. Section 3 focuses on the theoretical framework and the methodology employed in this research. Section 4 explored the influence factors of overseas warehouse deployment. Section 5 makes an empirical study of overseas warehouse deployment for China's export products. Section 6 presents the final remarks and conclusions. Section 7 indicates the limitations and future research.

2. Related Studies

2.1. Cross-Border E-Commerce and Cross-Border Logistics

With the development of cross-border e-commerce, cross-border e-commerce logistics as a new area is drawing scholars' attention as well. However, there is still relatively little academic research on cross-border e-commerce. The existing literature mainly focus on the operation modes of cross-border e-commerce [4,6–8]. As an important part in the realization of cross-border e-commerce trade, cross-border logistics seems to be slightly neglected, though there are a few studies on cross-border logistics services and networks [9–11]. Specifically, Giuffrida et al. [12] reviewed scientific publications in the field of logistics underlying cross-border e-commerce to China, and they found that within these contributions, studies investigating the relation between logistics and e-commerce, commonly acknowledged as critical, seem to be lacking. Sinkovics et al. [13] studied cultural adaptation in cross border e-commerce, taking German companies as an example. It is suggested that to engage better with their customer and reach better cultural congruency companies need to work harder on developing culturally adapted websites. Kawa [14] pointed out that the delivery of products remains a barrier to free cross-border flow, despite the dynamic development of e-commerce, and this problem can be solved by introducing an intermediary that consolidates shipments from many retailers and delivers them to clients scattered in different corners of the world, which is very similar to the concept of constructing overseas warehouses.

2.2. Logistics Warehouse Deployment Methods

In the traditional logistics field, research on logistics network planning and logistics warehouse layout has been very mature. Scholars proposed and applied a variety of methods and models on the layout of the logistics and site selection that can mainly be divided into two classes: quantitative methods and qualitative methods. Quantitative methods are mainly mathematical programming models [15–18] and set cover models [19,20], which are based on the minimum logistics transportation cost and shipping time. Qualitative methods are mainly analytic hierarchy process (AHP) [21–23], Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [24], and fuzzy clustering method (FCM) [25]. Besides, Jacyna-Gołda and Izdebski [26] turned multi-criteria decision-making problems into optimization problems using genetic algorithms to solve warehouse location problems.

2.3. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS is a classical multiple attribute decision making method that has been used in several fields [27,28]. For example, supply chain management [29], health, safety [30], environment management [31], energy management [32], land resource management, and other fields [33]. TOPSIS is a simple ranking method in conception and application. The standard TOPSIS method attempts to choose alternatives that simultaneously have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. In addition, TOPSIS makes full use of attribute information, provides a cardinal ranking of alternatives, and does not require attribute preferences to be independent. Several scholars have made attempts to propose improvements by extending or presenting new modifications of TOPSIS. The TOPSIS method is the second most popular method among multiple-criteria decision making (MCDM) approaches [34]. However, most of the existing studies are focused on the distance from the positive and negative solutions and the relative closeness to the ideal solution. To the best of our knowledge, at present, few studies have introduced the concept of centrality from complex network theory into TOPSIS research.

2.4. Incremental Contributions

The deployment of warehouse location is actually a complex multi-attribute decision and multi-objective decision problem, especially for overseas warehouse deployment [4]. There are seldom studies on overseas warehouse deployment for China's export products although China's cross-border e-commerce scale was ranked first in the world in 2017 [35]. Besides, this paper is different from the studies focusing only on transport cost and delivery time, it comprehensively considers demand value, logistics performance, trade potential, and the centrality of the countries in the B&R trade network, which is an important contribution to the existing literature, although the concept of centrality in complex networks theory has been used in various studies, for example [36,37]. The method in this paper which combined E-TOPSIS and centrality in complex networks is also an extension of the existing method. Furthermore, by doing a sensitivity experiment under different criteria weights, this paper provides various alternative proposals for decision makers.

3. Methodology

In Section 2, we can see that most of the research on the deployment of logistics warehouses and the layout of overseas warehouses uses mathematical programming models and intelligent algorithms to solve them. These models mainly aim at minimizing transportation cost and time cost. However, in the context of the BRI, the issues of overseas warehouse deployment of China's export products should not only consider the logistics cost and service efficiency of the business but also macro-economic factors, such as China's export trade volume and outward foreign direct investment to countries along the B&R, the status of these countries in the B&R trade network, and so on. Therefore, this paper applies a comprehensive decision-making method and an E-TOPSIS Model combined with centrality in complex networks theory to analyze the overseas warehouse deployment of China's export products in the context of the BRI. Namely, we use the entropy method in the first stage to determine the weight of each attribute and then the TOPSIS method in the second stage to make a multi-attribute comprehensive decision. A systematic scheme of the study is shown in Figure 2.

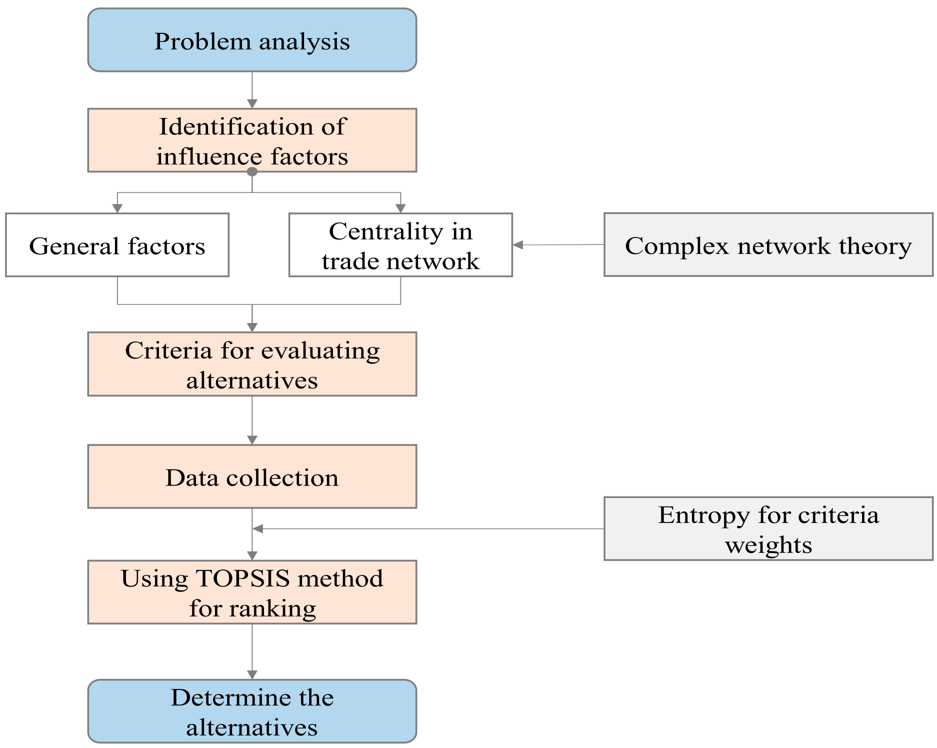

Figure 2. A systematic scheme of the study.

3.1. Weight Calculation

The most used method to determine the weights of indicators are AHP and the entropy weight method. Compared with AHP, the entropy weight method can avoid subjective effects [38]. Therefore, this article selects the entropy weight method to determine the weight of each indicator.

According to the basic principle of information theory, information is a measure of the orderly degree of a system and entropy is a measure of the disorderly degree of the system. The smaller the information entropy of an indicator, the greater the amount of information provided by the indicator, which means the indicators with small information entropy always play an important role in the comprehensive evaluation, and they should be given a high weight [39].

Let us consider the decision matrix R, which consists of alternatives and criteria, described by:

$$R = \begin{array}{c} \\ A_1 \\ \cdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \end{array} \tag{1}$$

where $A_1, A_2, \ldots, A_m$ are viable alternatives (candidate sites), $C_1, C_2, \ldots, C_n$ are criteria, and the rating of the i-th alternative candidate is denoted by x_{ij}, namely, x_{ij} is the value of the j-th criteria (C_j) for the i-th alternative (A_i), m is the number of alternatives, and n is the number of criteria.

Step 1: Construct the normalized matrix.

$$P = (p_{ij})m \times n = \begin{bmatrix} p_{11} & \cdots & p_{1n} \\ \vdots & \ddots & \vdots \\ p_{m1} & \cdots & p_{mn} \end{bmatrix} \tag{2}$$

where $p_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{m} (x_{ij})^2}$. Various dimensional attributes can be transformed into non-dimensional attributes through this process.

Step 2: Calculate the entropy of each attribute j.

$$e_j = -k \sum_{i=1}^{m} p_{ij} \cdot lnp_{ij} \tag{3}$$

$$k = 1/lnm \tag{4}$$

Step 3: determine the weight of each attribute j.

$$w_j = (1 - e_j) / \sum_{j=1}^{n} (1 - e_j) \tag{5}$$

3.2. TOPSIS Method

TOPSIS is a multi-criteria decision analysis method, which was originally developed by Hwang and Yoon [40]. Hwang et al. [41] made further developments for it, proposing TOPSIS for a multiple-objective decision making (MODM) problem. TOPSIS is used to identify solutions from a limited set of scenarios, and the rationale is that the chosen alternative should have the shortest geometric distance from the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS) [42]. This method has been widely applied to maritime transport and logistics [43].

This method can sort a variety of existing programs and select the optimal program. The specific steps are as follows:

Step 1: Construct the weighted normalized decision matrix $A = (a_{ij})$.

$$A = (a_{ij}) = p_{ij} \times w_j, i = 1, 2, \ldots m; j = 1, 2, \ldots n \tag{6}$$

Step 2: Determine the positive ideal solution a^+ and negative ideal solution a^-.

$$a^+ = \left(a_1^+, a_2^+, \ldots a_n^+\right) \tag{7}$$

$$a^- = \left(a_1^-, a_2^-, \ldots a_n^-\right) \tag{8}$$

$$a_j^+ = \begin{cases} \max\limits_i a_{ij}, \text{ j is benefit attribute} \\ \min\limits_i a_{ij}, \text{ j is cost attribute} \end{cases} \quad \mathrm{j} = 1, 2, \ldots, \mathrm{n} \tag{9}$$

$$a_j^- = \begin{cases} \max\limits_i a_{ij}, \text{ j is cost attribute} \\ \min\limits_i a_{ij}, \text{ j is benefit attribute} \end{cases} \quad \mathrm{j} = 1, 2, \ldots, \mathrm{n} \tag{10}$$

Step 3: Calculate the Euclidean distances from the positive ideal solution and the negative ideal solution.

The distance of each alternative candidate from the positive ideal solution is given as:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(a_{ij} - a_j^+\right)^2} \; i = 1, 2, \ldots, m \tag{11}$$

The distance of each alternative candidate from the negative ideal solution is given as:

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(a_{ij} - a_j^-\right)^2} \; i = 1, 2, \ldots, m \tag{12}$$

Step 4: Calculate the relative closeness of a particular alternative to the ideal solution.

$$C_i = \frac{d_i^-}{\left(d_i^- + d_i^+\right)} \; i = 1, 2, \ldots, m \tag{13}$$

Step 5: Rank the preference order based on the descending order of C_i.

4. Influence Factors of Overseas Warehouse Deployment

The lowest logistics costs, the best social and economic utility, and the highest level of service quality have always been the goals of logistics services. In the process of building a cross-border e-commerce logistics system, the layout of overseas warehouses is affected by both macro and micro factors.

Macro factors include political factors, economic factors, social factors, science and technology factors, legal factors, and so on. The main consideration of micro-factors is logistics cost minimization. The overseas warehouse logistics distribution services for export commodities include three links: the first-leg of transportation, storage control, and local distribution. In this study, we mainly focus on the first-leg of transportation link to research the cross-border e-commerce overseas warehouse deployment problem.

Considering the availability of data, 17 indicators that affect the layout of overseas warehouses were selected in this study to make comprehensive decisions on the deployment of overseas warehouses for China's export products in the context of the BRI. These 17 indicators can be divided into 4 categories, namely, (i) demand value; (ii) logistics performance; (iii) trade potential; and (iv) centrality in the B&R trade network; they are depicted in Figure 3.

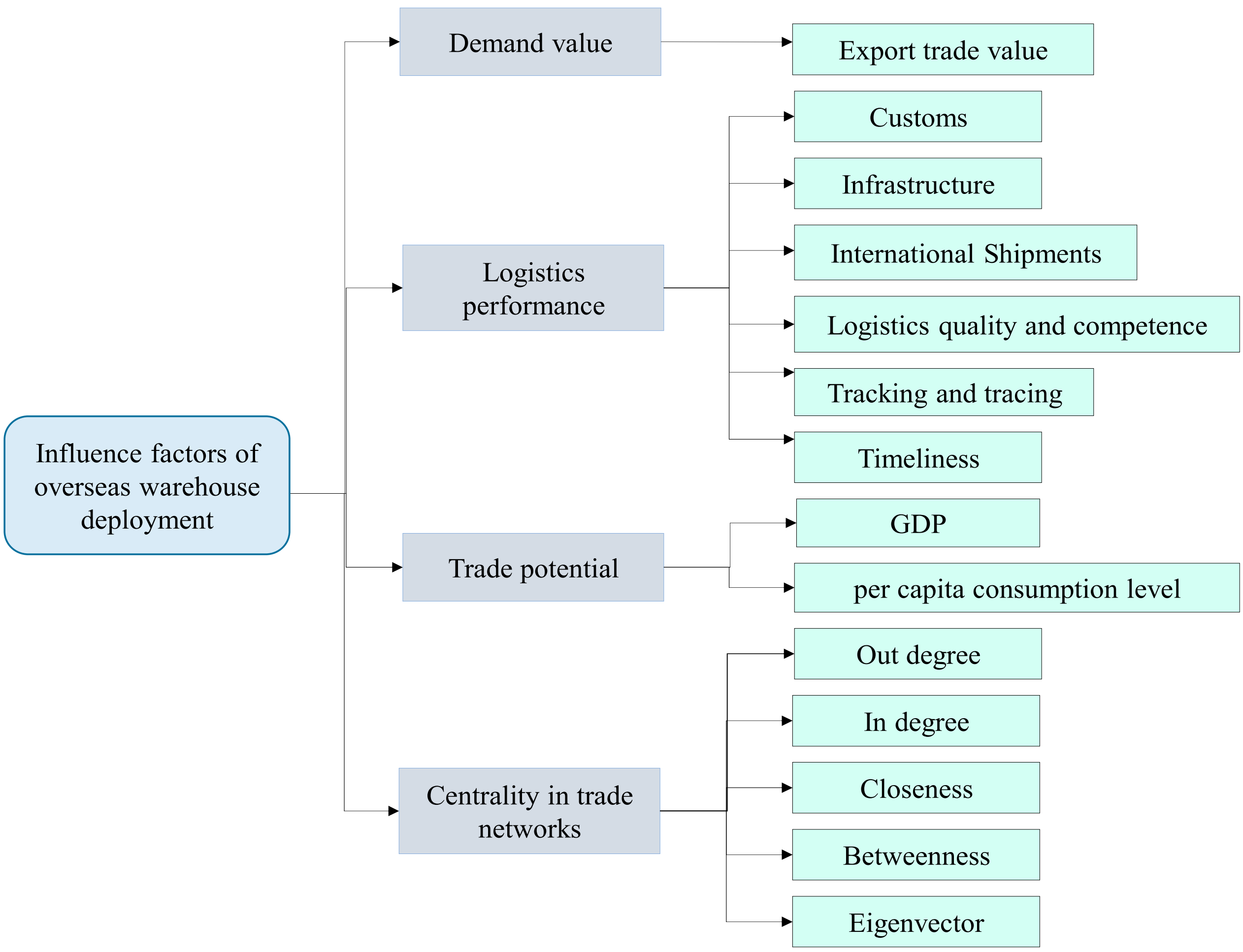

Figure 3. Influence factors of overseas warehouse deployment.

5. Empirical Study of Overseas Warehouse Deployment

5.1. Data Description

Thanks to the implementation of appropriate policy support and the progressive establishment of e-commerce platforms, China's cross-border e-commerce industry has demonstrated stable and rapid development in recent years [44].

This paper mainly studies the overseas warehouse deployment of China's export products under the BRI. Here, the countries along the B&R are taken as the demand points as well as the alternative nodes of overseas warehouses. We assume that transportation costs are directly proportional to transportation distance. China's export trade volume to these countries is taken as the overseas demand. Based on data availability, 62 countries along the B&R were selected in this study as demand nodes (which are also alternative nodes of overseas warehouses). The geographical distribution of each alternative node is shown in Figure 4.

As can be seen from Figure 4, there are 10 ASEAN countries; 1 East Asian country (Mongolia); 7 CIS countries; 8 South Asian countries; 18 Western Asian countries; 16 Central and Eastern European countries and 5 Central Asian countries among the 62 countries along the B&R selected in this paper.

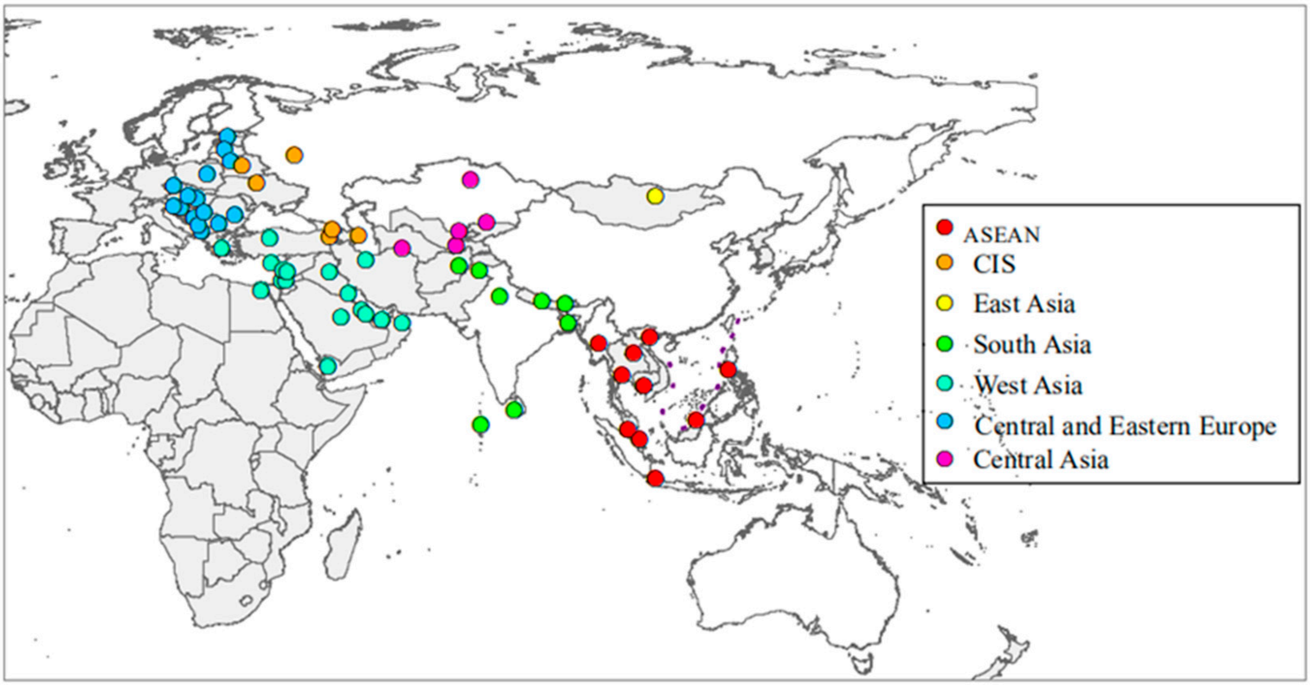

Figure 4. Geographical distribution of 62 alternative nodes.

In this paper, the data of Logistics Performance Index (LPI), Export Trade volume (ETV), Gross Domestic Product (GDP), and per capita consumption (PPC) level are from the World Bank website (https://data.worldbank.org/, accessed on 7 March 2022) and UNCTAD (https://comtrade.un.org/data/, accessed on 7 March 2022). The centrality values (D_{out}, D_{in}, CC, BC, EC) of each alternative candidate in the trading network are calculated according to the concept of centrality in complex networks. The specific definition and meaning of four kinds of centrality are shown below:

Outdegree and indegree are based on the number of edges connecting to each node. Outdegree is the number of outgoing edges from each node, and indegree is the number of incoming edges to each node, which are defined as:

$$D_{out}^{i} = \sum_{j} x_{ij} \tag{14}$$

$$D_{in}^{i} = \sum_{j} x_{ji} \tag{15}$$

where i is the focal node, j represents all other nodes, N is the total number of nodes, and x_{ij} is defined as 1 if node i is connected to node j, and 0 otherwise.

Closeness centrality relies on the length of the paths from a node to all other nodes in the network, and it is defined as the inverse total length. Betweenness relies on the identification of the shortest paths and measures the number of them that passes through a node. As a consequence, the closeness and betweenness centrality were asserted by [45], respectively:

$$C_C(i) = \left[\sum_{j}^{N} d(i,j) \right]^{-1} \tag{16}$$

$$C_B(i) = \frac{g_{jk}(i)}{g_{jk}} \tag{17}$$

where $d(i, j)$ represents the length of the paths from node i to node j, g_{jk} represents the number of binary shortest paths between two nodes, and $g_{jk}(i)$ is the number of those paths which go through node i.

The eigenvector centrality uses the eigenvector corresponding to the largest eigenvalue of the graph adjacency matrix. The scores are normalized such that the sum of all centrality scores is 1. Eigenvector centrality emphasizes the mutual influence between nodes, and the eigenvector of a node depends on the centralities of its neighbor nodes to a great extent. Suppose a network with N nodes, define A as the adjacent matrix of the network and let the values of $\lambda_1, \lambda_2, \ldots, \lambda_n$ be the principal eigenvalue of A. Hence, the corresponding eigenvector $e = (e_1, e_2, \ldots, e_n)^T$. We have

$$\lambda e_i = \sum_{i=1}^{n} a_{ij} e_j \tag{18}$$

and the eigenvector centrality of node i can be denoted by

$$C_e(i) = \lambda^{-1} \sum_{i=1}^{n} a_{ij} e_j \tag{19}$$

Table 1 presents summary statistics of the selected criteria. The maximum and minimum values for various criterions vary greatly. From the single factor, every alternative node has a big difference, especially from the perspectives of demand volume (export trade volume) and trade potential (GDP, PPC). This fully shows that the choice of overseas warehouse position cannot be based on a single factor. It needs to consider multiple attributes to make a comprehensive decision.

Table 1. Summary statistics of the selected criteria.

ETV		Customs		Infrastructure		IS		LQC	
Min	5.0	Min	1.110	Min	1.240	Min	1.360	Min	1.390
1st Qu	927.2	1st Qu	2.305	1st Qu	2.285	1st Qu	2.450	1st Qu	2.330
Median	2565.0	Median	2.640	Median	2.660	Median	2.915	Median	2.775
Mean	9452.6	Mean	2.657	Mean	2.726	Mean	2.870	Mean	2.777
3rd Qu	9900.0	3rd Qu	3.100	3rd Qu	3.188	3rd Qu	3.317	3rd Qu	3.200
max	61,094.0	max	4.180	max	4.200	max	3.960	max	4.090
TT		**Timeliness**		**GDP**		**PCC**		**Outdegree**	
Min	1.770	Min	2.040	Min	22.37	Min	390	Min	0.00
1st Qu	2.447	1st Qu	2.882	1st Qu	216.42	1st Qu	2408	1st Qu	46.25
Median	2.860	Median	3.345	Median	593.44	Median	6439	Median	58.50
Mean	2.847	Mean	3.295	Mean	1992.03	Mean	11127	Mean	46.23
3rd Qu	3.250	3rd Qu	3.627	3rd Qu	2167.15	3rd Qu	12924	3rd Qu	60.00
max	4.050	max	4.400	max	22,640.00	max	73725	max	61.00
Indegree		**Closeness**		**Betweenness**		**Eigenvector**			
Min	28.00	Min	64.89	Min	28.00	Min	64.89		
1st Qu	45.00	1st Qu	88.12	1st Qu	45.00	1st Qu	88.12		
Median	47.00	Median	97.61	Median	47.00	Median	97.61		
Mean	46.23	Mean	93.45	Mean	46.23	Mean	93.45		
3rd Qu	49.00	3rd Qu	100.00	3rd Qu	49.00	3rd Qu	100.00		
max	50.00	max	100.00	max	50.00	max	100.00		

Note: ETV: export trade volume; IS: International shipments; LQC: Logistics quality and competence; TT: Tracking and tracing; PCC: per capita consumption level.

5.2. Empirical Results

Based on the above data, MATLAB7.0 software is used to solve the problem. Firstly, the entropy weight method is used to determine the weight of each attribute j. The specific results are shown in Table 2.

Table 2. Weight of each criterion.

Attributes	**ETV**	**Customs**	**Infrastructure**	**IS**	**LQC**
w_j	0.3043	0.0080	0.0083	0.0058	0.0066
Attributes	TT	Timeliness	GDP	PCC	Outdegree
w_j	0.0066	0.0040	0.3167	0.1865	0.0733
Attributes	Indegree	Closeness	Betweenness	Eigenvector	
w_j	0.0012	0.0014	0.0752	0.0021	

Note: ETV: export trade volume; IS: International shipments; LQC: Logistics quality and competence; TT: Tracking and tracing; PCC: per capita consumption level.

It is clear from Table 2 that export trade volume owns the highest weight of 0.3043. Because overseas warehouse construction must take customer service as a general goal, the overseas warehouse should be as close to the terminal market as possible. Therefore, the most important factor is overseas demand, namely, the export trade volume. The GDP and PPC are ranked at the second and third place with the weight of 0.3167 and 0.1865, respectively, followed by the betweenness centrality of each node. Betweenness centrality relies on the identification of the shortest paths, which reflects the transportation costs to some extent.

Then, the TOPSIS algorithm is used to find the relative closeness of a particular alternative to the ideal solution, and the alternative nodes are ranked based on the descending order of C_i. The specific results are shown in Table 3 and the geographical distribution is depicted in Figure 5.

Table 3. The results of Entropy TOPSIS analyses.

Country	C_i	**Rank**	**Country**	C_i	**Rank**	**Country**	C_i	**Rank**
India	0.6278	1	Lithuania	0.2662	22	Serbia	0.1973	43
Singapore	0.5042	2	Greece	0.2632	23	Montenegro	0.1970	44
Russia	0.4695	3	Hungary	0.2596	24	Ukraine	0.1952	45
Qatar	0.4460	4	Brunei	0.2504	25	Mongolia	0.1828	46
UAE	0.4149	5	Romania	0.2441	26	Maldives	0.1791	47
Indonesia	0.4048	6	Estonia	0.2399	27	Nepal	0.1787	48
Vietnam	0.3796	7	Cyprus	0.2390	28	Albania	0.1782	49
Turkey	0.3789	8	Iran	0.2378	29	Kyrgyzstan	0.1755	50
Israel	0.3667	9	Oman	0.2351	30	Georgia	0.1744	51
Thailand	0.3556	10	Kazakhstan	0.2233	31	Afghanistan	0.1679	52
Malaysia	0.3542	11	Latvia	0.2228	32	Uzbekistan	0.1648	53
Poland	0.3280	12	Bosnia Herzegovina	0.2212	33	Yemen	0.1600	54
Saudi Arabia	0.3274	13	Bulgaria	0.2146	34	Laos	0.1524	55
Czech	0.3062	14	Croatia	0.2115	35	Armenia	0.1428	56
Kuwait	0.3040	15	Belarus	0.2109	36	Bhutan	0.1305	57
Philippines	0.2893	16	Cambodia	0.2109	37	Tajikistan	0.1290	58
Bahrain	0.2878	17	Azerbaijan	0.2108	38	Myanmar	0.1245	59
Slovenia	0.2770	18	Jordan	0.2048	39	Iraq	0.1188	60
Pakistan	0.2721	19	Bangladesh	0.2039	40	Turkmenistan	0.1072	61
Slovakia	0.2701	20	Lebanon	0.1981	41	Syria	0.0895	62
Egypt	0.2684	21	Sri Lanka	0.1977	42			

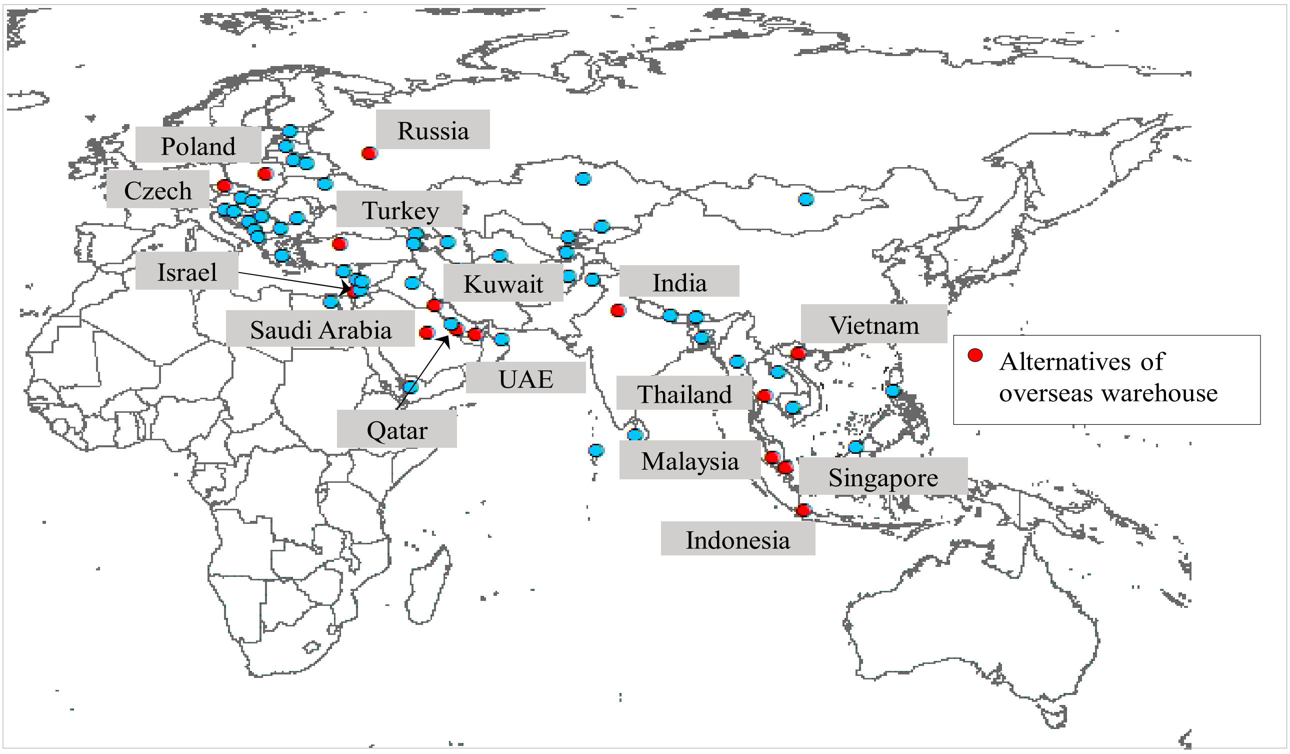

Figure 5. Geographical distribution of 15 alternative nodes for overseas warehouses.

Based on the value of the relative closeness of a particular alternative to the ideal solution (C_i), the ranking of the alternative nodes in descending order is presented in Table 3. According to the comprehensive results, the top fifteen alternatives are India, Singapore, Russia, Qatar, UAE, Indonesia, Vietnam, Turkey, Israel, Thailand, Malaysia, Poland, Saudi Arabia, Czech, and Kuwait.

India has become the seventh largest exporter of Chinese goods in the world. Specifically, the Good and Service Tax (GST) system carried out by India on 1 January 2017 reduced taxes on Chinese exports to India, which will promote the development of cross-border e-commerce between China and India. Besides, Indian e-commerce businesses also began to pay attention to China's cross-border export market recently. For example, approximately 40% of the goods sold by India's most active e-commerce company-Paytm mall are from China. Registering a company in India and using the overseas warehouse model to stock goods in India has gradually become a cross-border e-commerce channel for Chinese sellers to connect with Indian consumers. Furthermore, as predicted by eMarketer, Indian e-commerce retail sales will reach $37.5 billion in 2017, and by 2020 that number will reach $79.4 billion. India's consumers shopping through e-commerce platforms will also grow from 199 million in 2017 to 352 million in 2020 [46]. Therefore, for Chinese export products, India is the preferred place to establish overseas warehouses.

Singapore, as one of the busiest ports in the world and one of Asia's major transit hubs, is the world's largest logistics center and the world's trading hub, having a superior geographical advantage in international trade and international logistics. Simultaneously, Singapore has a well-developed digital infrastructure and is one of the regions with the highest Internet penetration rates in Southeast Asia. In terms of e-commerce, Singapore's e-commerce market is expected to reach $5.4 billion by 2025 [47].

5.3. Sensitivity Analysis

A sensitivity analysis was conducted to further study the manner of the overseas warehouses' location under different criteria weights. The idea of sensitivity analysis is to exchange each criterion's weight with another criterion's weight. There are 14 criteria, so 91 combinations of the 14 criteria should be analyzed. To simplify the problem, these 14 criteria are divided into 4 parts as is shown in Figure 4. Namely, (i) demand value; (ii) logistics performance; (iii) trade potential; (iv) centrality in B&R trade network. So, the weights of these four criteria are: 0.3043, 0.0393, 0.5032, and 0.1532, and this result is used as the main condition in sensitivity analysis. Therefore, six combinations of four criteria are analyzed eventually, as shown in Table 4. The results of the sensitivity analysis are presented in Table 5.

Table 4. Six combinations of four criteria for sensitivity analysis.

Conditions	Weights of Criteria			
	Demand Value	Logistics Performance	Trade Potential	Centrality in Trade Network
main	0.3043	0.0393	0.5032	0.1532
1	0.0393	0.3043	0.5032	0.1532
2	0.5032	0.0393	0.3043	0.1532
3	0.1532	0.0393	0.5032	0.3043
4	0.3043	0.5032	0.0393	0.1532
5	0.3043	0.1532	0.5032	0.0393
6	0.3043	0.0393	0.1532	0.5032

Table 5. Results of sensitivity analysis.

Alternatives	Main	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5	Condition 6
1	India	India	Bangladesh	Slovakia	India	Egypt	Romania
2	Russia	Qatar	Nepal	Nepal	Singapore	Bosnia Herzegovina	Estonia
3	Singapore	Russia	Ukraine	Albania	Russia	Montenegro	Ukraine
4	Qatar	Singapore	Tajikistan	Georgia	UAE	Turkmenistan	Slovakia
5	Indonesia	Israel	Bahrain	Cyprus	Turkey	Slovenia	Syria
6	UAE	Turkey	Syria	Armenia	Indonesia	Bhutan	Iraq
7	Israel	UAE	Yemen	Pakistan	Malaysia	Pakistan	Uzbekistan
8	Turkey	Saudi Arabia	Belarus	Laos	Thailand	Kyrgyzstan	Nepal
9	Saudi Arabia	Indonesia	Myanmar	Mongolia	Vietnam	Myanmar	Laos
10	Poland	Poland	Uzbekistan	Jordan	Israel	Azerbaijan	Georgia
11	Vietnam	Kuwait	Serbia	Romania	Qatar	Armenia	Jordan
12	Thailand	Czech	Kyrgyzstan	Uzbekistan	Saudi Arabia	Nepal	Oman
13	Malaysia	Malaysia	Slovakia	Greece	Poland	Lebanon	Czech
14	Kuwait	Thailand	Montenegro	Azerbaijan	Czech	Lithuania	Brunei
15	Czech	Greece	Brunei	Indonesia	Lithuania	Czech	Lithuania

According to Tables 4 and 5, India has the highest value of C_i, when the weights of four criteria are in the main condition, condition 1 and 4. Specifically, India gets the highest value of C_i, and it is the most important place to build overseas warehouses, when the trade potential and the logistics performance have the highest weights.

Bangladesh will have the highest C_i value, when the weights of the demand value and the trade potential are exchanged in condition 2. Bangladesh is one of the least developed countries in the world: it lacks resources and it has a large population, backward production technology, and weak industrial base. However, for this reason, its materials from production to life, such as grain, cotton, sugar, cooking oil, industrial raw materials, machinery and equipment, and transportation vehicles, mainly rely on imports. Therefore, huge trade potential exists in Bangladesh.

Slovakia will have the highest C_i value when the weights of demand value and centrality in trade networks are exchanged in condition 3. Namely, the weight of centrality in the B&R trade network is higher than the demand value. As a landlocked country of Central Europe, Slovakia is bordered by the Czech Republic in the northwest, Poland in the north, Ukraine in the east, Hungary in the south and Austria in the southwest. It is an important node of Sino-European trade in the Silk Road Economic Belt.

Egypt will have the highest C_i value when the weights of logistics performance and centrality in trade network are exchanged in condition 5. Namely, the weight of logistics performance is higher than centrality in the B&R trade network. Egypt is one of the countries with the best logistics performance in low- and middle-income countries around the world. Besides, located at the crossroads of Europe, Asia, and Africa, Egypt is a shortcut between the Atlantic Ocean and the Indian Ocean. Therefore, it has a strategic position in global economic trade, and it is an important node for China's export products to establish overseas warehouses.

Romania will have the highest C_i value when the weights of trade potential and centrality in trade network are exchanged in condition 6. Namely, the weight of centrality in the B&R trade network is higher than the trade potential because 60 countries along the B&R directly trade with Romania, and Romania has the highest closeness centrality and betweenness centrality in the B&R trade network, which suggests that Romania can be chosen as a transit hub of the overseas warehouse for China's export products.

Additionally, Indonesia and Greece will be selected if conditions 1 and 3 are met compared with the main condition. On the other hand, the Czech Republic will be selected in conditions 1 and 4–6. The Czech Republic and Lithuania will be selected if conditions 4 and 5 are met. Nepal, Uzbekistan, and Slovakia will be selected if conditions 2 and 3 are met. Therefore, the decision-maker can use these different weight combinations in the decision-making process according to priority.

6. Conclusions and Implications

In recent years, with the rapid development of cross-border e-commerce, the problem of cross-border logistics has become increasingly prominent. Overseas warehouses provide a new solution for ensuring the safety and the smoothness of cross-border logistics, improving the level of cross-border trade services, and promoting the high-quality development of the Belt and Road [48].

In this paper, we investigated the determination factors of overseas warehouses for cross-border e-commerce and proposed a comprehensive method combined with E-TOPSIS and centrality in complex networks to find the optimal overseas warehouse locations for Chinese export products along the B&R. Our main findings are as follows: (1) Consistent with the findings of many previous studies on logistics warehouse locations, results show that freight demand is the most important factor influencing cross-border e-commerce overseas warehouse locations [49,50], followed by economic development level (GDP and PPC). This is mainly because trade demand is the key cause of logistics, and the level of economic development or GDP and per capita consumption of a region determines the trade demand of the area; (2) The betweenness centrality and outdegree centrality in a global trade network and the logistics infrastructure are also important factors in cross-border e-commerce overseas warehouse locations, which just ranked fourth, fifth, and sixth, respectively. These three factors represent the potential logistics convenience radiation to its surrounding markets. Therefore, overseas warehouse location models should account for the node centrality in the trade network and its logistics performance as well; (3) India, Singapore, Russia, Qatar, UAE, Indonesia, Vietnam, Turkey, Israel, Thailand, Malaysia, Poland, Saudi Arabia, Czech, and Kuwait are the top 15 best alternatives of overseas warehouses for Chinese export products in the context of the B&R. Among them, only three countries (Russia, Poland, and Czech) are on the Silk Road Economic Belt, and the remaining 12 countries are all countries along the 21st Century Maritime Silk Road. Russia has a superior geographical position across the Eurasian Continental Bridge, and in recent years cross-border e-commerce has developed rapidly in Russia, which shows a huge market potential [51]. As the largest country and economy in Eastern Europe, Poland has close trade relations with China: China is Poland's largest trading partner and its third largest source of imports in Asia. The Czech Republic is China's second largest trading country in Central and Eastern Europe, closely following Poland. Moreover, the Czech Republic is the heartland of Eastern Europe, and it has an extremely important position in economy, trade, and transportation. Moreover, the Czech Republic has also seen opportunities in the development of the Belt and Road, such as the construction of logistics centers. Currently, the Czech Ministry of Transport is working on planning in this area. In summary, this also justifies the correctness and the rationality of the results obtained by the proposed method in this paper.

Based on our analytical results, we proposed the following implications. With the steady development of the B&R, Chinese e-commerce platforms and export companies should give priority to the construction of overseas warehouses in the following 15 countries: India, Singapore, Russia, Qatar, UAE, Indonesia, Vietnam, Turkey, Israel, Thailand, Malaysia, Poland, Saudi Arabia, Czech, and Kuwait. In addition, the COVID-19 pandemic is still spreading around the world, bringing a huge impact on the world economy and trade. At the same time, it has also prompted changes in the consumption habits of consumers in various countries, and some offline needs have been transferred online, which directly corresponds to the growth of cross-border e-commerce for end consumers against the trend. Therefore, cross-border e-commerce platforms and enterprises should accelerate the layout and the construction of overseas warehouses. However, the outbreak of the COVID-19 pandemic has caused many uncertainties, and overseas warehouse operators should appropriately increase awareness of risk prevention.

What's more, a sensitivity experiment was conducted to analyze the manner of the overseas warehouses' locations under different criteria weights. Therefore, the decision-maker can use these different weight combinations in the decision-making process, according to priority. The approach taken by this paper can be undertaken for other countries or for company's overseas warehouse location deployment.

7. Limitations and Future Research

While the results of the method proposed in this paper are reasonable and the ranking is significant from the mathematical value, although some cities may have a similar potential for warehouses, a cluster analysis may be better. Besides, due to the availability of data, we do not use online trade flows in this work; we simply find the optimal countries for overseas warehouse locations without specific cities. These may also be considered as future research directions.

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