

# Analysis of Lemon Company's Cross-Border E-Commerce Logistics Distribution Mode Selection



Li Qin Hu, Amit Yadav, Hong Liu, Sami Azam, Asif Karim, Bharanidharan Shanmugam, Abdul Hasib Siddique, and Mehedi Hasan

**Abstract** A detailed study of cross border e-commerce of lemon company has been done, it analyzes and summarizes its business products, main consumer objectives, existing logistical distribution model and combines the status of logistical operations of Lemon Company to analyze the logistical aspects of Lemon Company. Existing problems and factors that affect the choice of the logistical company's distribution model are analyzed in detail. An index system for the selection of cross-border e-commerce logistical distribution models has also been constructed. Existing logistical system has been comprehensively analyzed through expert scoring and other methods. Quantitative scoring of the index factors of the distribution model has been computed using the analytic hierarchy process and Matlab. Final comprehensive score of the three types of logistics distribution modes of the cross-border e-commerce company has been computed. A choice has been made for the logistical and distribution mode suitable for Lemon Company which can be used as overseas warehouse and distribution mode.

**Keywords** Cross-border e-commerce · Logistics distribution model · Cross-border logistics

---

L. Q. Hu

Department of Information Management, Chengdu Neusoft University, Chengdu, China

A. Yadav

Department of Information and Software Engineering, Chengdu Neusoft University, Chengdu, China

H. Liu

Department of Human Resources, Chengdu University of Technology, Chengdu, China

S. Azam · A. Karim (✉) · B. Shanmugam

College of Engineering, IT and Environment, Charles Darwin University, Darwin, NT, Australia  
e-mail: [asif.karim@cdu.edu.au](mailto:asif.karim@cdu.edu.au)

A. H. Siddique · M. Hasan

Department of Computer Science and Engineering, University of Science and Technology Chittagong, Chittagong, Bangladesh

# 1 Introduction

## 1.1 Lemon (L) Company Background

Lemon Cross-border e-commerce Company is an export cross-border B2C enterprise integrating Amazon trade export and logistics system services. It has its own warehouses in Shenzhen, Shanghai and other places, with overseas sales of about 16 million RMB/year. Company Lemon's export retail e-commerce platform has opened up various links such as logistics, payment, customs declaration, and has developed its own ERP system, the company is using franchise model to expand its business. At present, the number of franchise have reached 50 and all shipments are handled by the logistical department of Lemon Company [1].

Company's upstream supply chain includes well-known domestic manufacturers, and on the other hand downstream companies are mainly domestic or foreign logistical companies with cross-border logistical operations. At present, the company mainly serves C-end consumers mainly in USA, UK, and provides one-stop shopping services for foreign consumers. The flowchart of the companies (Fig. 1).

1. *Virtual delivery:*  
According to the characteristics of the goods and customer needs, selection of the appropriate logistics distribution mode is done.
2. *Prompt purchase:*  
The company finds the cargo information and notify the seller to send it quickly.
3. *Transit of goods:*  
After receiving the goods from the seller Lamon company does a QA survey of the product and sends it forward if it qualifies according to the standard in case if fails to comply to the standard then it notifies the seller to send a new product.
4. *Cargo tracking:*  
A real time tracking of the shipment is done through feedback method. Any abnormalities is also taken care off.

In a fiercely competitive market, as a small and medium-sized cross-border export e-commerce company must not only consider more supporting professional services and technological improvements in its development process, but also consider how to better serve the customers while making profit is optimal. Therefore, saving logistics costs and choosing the most reasonable logistics distribution model will become the profitable channel for Lemon Company. On the premise of ensuring the quality of logistics services, it is particularly important to choose a reasonable logistics distribution model.



**Fig. 1** Delivery process of Lemon Company. *Data Source* [WWW.100EC.CN](http://WWW.100EC.CN)

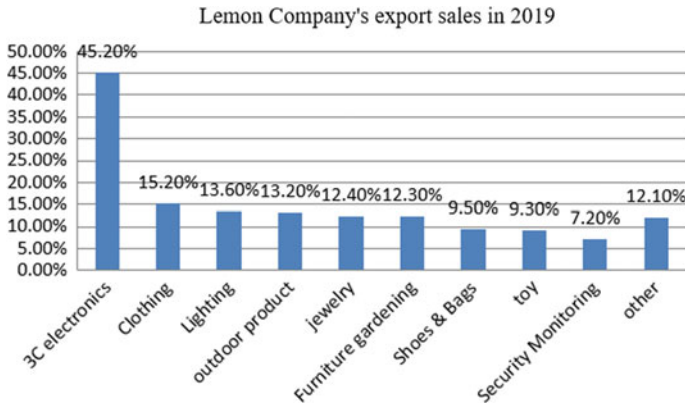


Fig. 2 Lemon Company's export sales in 2019. Data Source [WWW.100EC.CN](http://WWW.100EC.CN)

### 1.2 Company L Export Product

The main products exported by Lemon Company are based on the daily need of a customer. For example, lighting, safety monitoring, clothing, These are divided into 3C electronic products and household products, which are all non-dumping products. 3C electronic products mainly include: mouse, keyboard, screen display, camera, game console, etc. Among these 3C products the sales of mouse and keyboard are relatively higher than the others. Clothes, jewelry, toys, clothing, hats, stationery are all products under the household category. The export sales of the Lemon Company in 2019 is shown in Fig. 2.

### 1.3 Overseas Operation

In order to avoid logistics congestion during the peak period, and to make sure that the goods can reach the consumers safely and quickly the company took some innovative measures.

At a fixed time every year, Lemon Company delivers the goods in advance to an overseas warehouse which is close to Nepal, thereby realizing the time value of storage [2]. Lemon Company then publishes its products on the cross-border e-commerce platform. Foreign buyers place orders on the that platform according to the demand. After receiving the order information, the sellers will share its shipping information and notify the overseas warehouse manager to send it in advance. Overseas warehouse staff will cooperate with overseas courier companies to securely deliver the products to overseas buyers. The advantage of this delivery model is that it saves time required for customs clearance and other processes. Hence one can responds to customer needs more quickly [1]. Although overseas warehousing and

distribution modes are very advantageous in terms of logistical timeliness, but there is huge pressure from the same industry, other emerging logistics and distribution modes such as border warehouses.

For international express, Lemon Company uses the three international express delivery services namely TNT, UPS and DHL. Generally, the aging time from China to the United States is about 3–7 days. As international courier is fast, so Lemon Company usually chooses international courier to ship according to customers' requirements. In order to ensure customer satisfaction and on time delivery of the goods, Lemon Company chooses an international express logistics distribution model [1].

At present, postal parcel is the most common logistical distribution model of Lemon Company. The postal parcel delivery model is mainly used to deliver some home kitchen products. Although the delivery time is slower than other logistical delivery models, but there are no additional delivery fee for this mode to deliver in the remote areas.

## 2 Lemon Company's Cross-Border Logistics Distribution Model Selection

Even though the sales of the company is quite good but there are many areas where Lemon Company still needs to improve such as logistics cost issues, on time delivery of logistics and low number of returning customers. In order to solve these problems the following need to be established in the logistical distribution. Mode selection indicators for Lemon Company from both the strategic and tactical levels and comprehensively analyze the various indicators that affect the Lemon Company logistics distribution. In order to establish an analysis model Lemon Company's choice of logistics distribution mode needs to be more rational and quality of service needs to be high [1, 3].

According to the company's strategic and tactical index factors. Distribution can be divided into the different level of the company's logistical distribution mode. This is done according to the analytic hierarchy process. The second-level for strategic and tactical is the standard level. It includes export tax rate laws and regulations, consumer environment, logistics technology, product attributes, the price of logistics, the timeliness of logistics, the quality of logistics services, the strength of the company, and the needs of buyers are the sub-criteria layer, and the lowest layer is the program layer [2, 3] as shown in Fig. 3.

Company exports and the logistics distribution model it chooses to export. Of course, the products exported by Lemon Company also need to choose the appropriate logistics and distribution mode according to the attributes of the products and the consumer's requirements for timeliness. For the Company, the logistics price refers to the logistics costs required in the unit order, including the surcharges that may occur when selecting the international express logistics distribution mode, remote

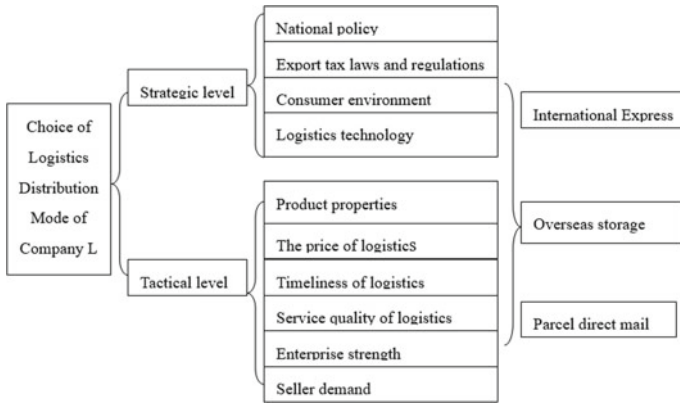


Fig. 3 Index system table. Data Source WWW.100EC.CN

area distribution fees, and transportation costs based on weight or volume, etc. In addition, the overseas storage costs, manual sorting, and packaging costs are collectively calculated as the company’s logistics price. This is also the direct cost of Lemon Company’s loss in a short period of time. The scale of the company will limit the Lemon Company’s choice of logistics distribution mode, such as the idea of building overseas warehouses, can only rent overseas warehouses, relying on third parties [1, 3].

The index weights obtained by the grey correlation method combined with the analytic hierarchy process are used to calculate the comprehensive score. First, the calculated scoring level is established, and then analytic hierarchy method is similarly set as a nine-level scoring standard [2, 4, 5].

Secondly, for the above indicators, Lemon Company interviewed 15 experts in related fields to score and calculate their average scores, and constructed corresponding judgment matrices for the secondary and tertiary indicators. The related scoring tables can be summarized as shown in Table 1. According to expert evaluation the strategic level matrix and tactical level matrix had been created [2, 4, 5].

By using the data of the three tables, the weights of the secondary and tertiary indicators had been calculated using the Matlab matrix factory.

Next, from the 15 expert scoring tables, 5 copies were randomly selected using the gray correlation method to grade the index to construct an index sample matrix.

En(n = 1, 2, 3, 4, 5) : Means an expert.

Table 1 Expert evaluation table for secondary indicators

	Strategic level	Tactical level
Strategic level	1	1/3
Tactical level	3	1

$I_{ij}$  ( $i = 1,2; j = 1, 2, 3, 4, 5, 6$ ): Represents the indicators that affect the selection of the logistics model of Lemon Company. The abbreviations of related indicators are  $I_{11}$  = National policy,  $I_{12}$  = Export tax laws and regulations,  $I_{13}$  = Consumer environment,  $I_{14}$  = Logistic technology,  $I_{21}$  = product properties,  $I_{22}$  = the price of logistics,  $I_{23}$  = Timeliness of logistics,  $I_{24}$  = Service quality of logistics,  $I_{25}$  = Enterprise strength,  $I_{26}$  = Seller demand. Experts' scores on international express delivery are shown in Table 2, scores of experts in direct mail mode is shown in Table 3 and scores of experts for overseas warehousing is shown in Table 4.

By using the above related score calculations have been done in the next section to obtain a comprehensive score of the three schemes, which provides a reference for the selection of the company's cross-border logistics distribution model.

**Table 2** Expert scores for international express delivery models

$I_1$	E1	E2	E3	E4	E5	$I_2$	E1	E2	E3	E4	E5
$I_{11}$	6	7	6	8	7	$I_{21}$	5	4	6	6	4
$I_{12}$	8	7	7	8	7	$I_{22}$	6	6	7	6	7
$I_{13}$	6	5	7	6	6	$I_{23}$	4	5	5	4	6
$I_{14}$	7	7	9	7	8	$I_{24}$	3	5	4	3	4
						$I_{25}$	5	4	5	6	6
						$I_{26}$	5	7	5	6	5

**Table 3** Scores of experts in direct mail mode

$I_1$	E1	E2	E3	E4	E5	$I_2$	E1	E2	E3	E4	E5
$I_{11}$	6	8	8	6	7	$I_{21}$	4	5	3	4	4
$I_{12}$	8	6	7	7	7	$I_{22}$	5	4	3	3	4
$I_{13}$	8	7	8	9	8	$I_{23}$	7	8	6	7	8
$I_{14}$	5	6	7	6	7	$I_{24}$	4	3	5	5	5
						$I_{25}$	4	3	3	5	3
						$I_{26}$	5	5	7	5	7

**Table 4** Scores of experts for overseas warehousing

$I_1$	E1	E2	E3	E4	E5	$I_2$	E1	E2	E3	E4	E5
$I_{11}$	7	9	8	7	7	$I_{21}$	7	5	6	8	6
$I_{12}$	6	7	6	5	6	$I_{22}$	5	6	6	4	5
$I_{13}$	8	8	7	8	7	$I_{23}$	7	8	8	7	6
$I_{14}$	4	5	4	3	5	$I_{24}$	5	4	6	5	4
						$I_{25}$	4	4	6	5	3
						$I_{26}$	3	5	4	5	4

### 3 Construction of Evaluation Model and Analysis

The entire evaluation model calculation process is as follows:

#### 3.1 Analytic Hierarchy Process to Calculate Index Weight

Through the analytic hierarchy model and the expert’s scoring of indicators. Two-level indicator construction matrix, three-level indicator strategic-level indicator judgment matrix, and three-level tactical-level indicator judgment evidence matrix have been constructed [2, 4–6].

Secondary indicator judgment matrix

$$\begin{bmatrix} 1 & 1/3 \\ 3 & 1 \end{bmatrix}$$

Three-level indicator Strategic level indicator judgment matrix:

$$\begin{bmatrix} 1 & 4 & 3 & 3 \\ 1/4 & 1 & 1/5 & 1/3 \\ 1/3 & 5 & 1 & 3 \\ 1/3 & 3 & 1/3 & 1 \end{bmatrix}$$

Three-level indicator tactical level indicator judgment matrix:

$$\begin{bmatrix} 1 & 1 & 1 & 4 & 1 & 1/2 \\ 1 & 1 & 2 & 4 & 1 & 1/2 \\ 1 & 1/2 & 1 & 5 & 3 & 1/2 \\ 1/4 & 1/4 & 1/5 & 1 & 1/3 & 1/3 \\ 1 & 1 & 1/3 & 3 & 1 & 1 \\ 2 & 2 & 2 & 3 & 1 & 1 \end{bmatrix}$$

After Matlab calculations weight of the secondary indicator is given by [0.25 0.75]. The weight of the three-level indicator at the strategic level is given by [0.4910, 0.0706, 0.2929, 0.1454], where  $CI = 0.0846$ ,  $CR = CI/RI = 0.0846/0.90 = 0.0940 < 0.1$ , Consistency check has been done and it passed.

The weight of the three-level indicators at the tactical level is given by [0.1584, 0.1892, 0.1908, 0.0483, 0.1502, 0.2558], where  $CI = 0.0841$ ,  $CR = CT/RI = 0.0481/1.24 = 0.0678 < 0.1$ , Consistency check have been done it also passed. The weights of the indicators are computation are shown in Table 5.

**Table 5** Three-level indicator weights

Evaluation target index	Second-level index	Weight	Third-level	Weight
Lemon Company’s cross-border e-commerce logistics distribution model selection	Strategic	0.25	National policy	0.4910
			Export tax laws and regulations	0.0706
			Consumer environment	0.2929
			Logistics technology	0.1454
	Tactical	0.75	Product properties	0.1584
			The price of logistics	0.1892
			Timeliness of logistics	0.1908
			Service quality of logistics	0.0483
			Enterprise strength	0.1502
			Seller demand	0.2558

### 3.2 The Relevant Gray Evaluation Numbers Are Calculated as Follows

The number of gray evaluations for the international express delivery model is as follows [2, 4–8]:

1. In the first gray level of this mode [8]: Pass the expert’s score on international express through the first gray function [7].

$$\varphi 1(f_{ijr}) = \begin{cases} 1 & f_{ijr} \geq 9 \\ \frac{f_{ijr}}{9} & 0 < f_{ijr} < 9 \\ 0 & f_{ijr} \leq 0 \end{cases}$$

And gray rating function:

$$X_{ijr} = \varphi x(f_{ij1}) + \varphi x(f_{ij2}) + \dots + \varphi x(f_{ijm})$$

where from analysis we got  $X_{111} = 34/9$ ,  $X_{121} = 37/9$ ,  $X_{131} = 30/9$ ,  $X_{141} = 38/9$ ,  $X_{211} = 25/9$ ,  $X_{221} = 32/9$ ,  $X_{231} = 24/9$ ,  $X_{241} = 19/9$ ,  $X_{251} = 26/9$ ,  $X_{261} = 28/9$ .

2. By the second grayscale function:

$$\varphi 2(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{7} & 0 < f_{ijr} < 7 \\ \frac{14-f_{ijr}}{9} & 7 \leq f_{ijr} < 14 \\ 0 & f_{ijr} \leq 0 \end{cases}$$



And gray rating function

$$X_{ijr} = \varphi x(f_{ij1}) + \varphi x(f_{ij2}) + \dots + \varphi x(f_{ijm})$$

From analysis we got,  $X_{112} = 32/7, X_{122} = 33/7, X_{132} = 30/7, X_{142} = 32/7, X_{212} = 25/7, X_{222} = 32/7, X_{232} = 24/7, X_{242} = 19/7, X_{252} = 26/7, X_{262} = 28/7.$

3. By the third gray function:

$$\varphi 3(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{5} & 0 < f_{ijr} < 5 \\ \frac{10-f_{ijr}}{9} & 5 \leq f_{ijr} < 10 \\ 0 & f_{ijr} \leq 0 \end{cases}$$

And gray rating function

$$X_{ijr} = \varphi x(f_{ij1}) + \varphi x(f_{ij2}) + \dots + \varphi x(f_{ijm})$$

From analysis we got,  $X_{113} = 16/5, X_{123} = 13/5, X_{133} = 20/5, X_{143} = 12/5, X_{213} = 21/5, X_{223} = 18/5, X_{233} = 22/5, X_{243} = 19/5, X_{253} = 22/5, X_{263} = 22/5.$

4. Through the fourth gray function:

$$\varphi 4(f_{ijr}) = \begin{cases} \frac{f_{ijr}}{3} & 0 < f_{ijr} < 3 \\ \frac{6-f_{ijr}}{9} & 3 \leq f_{ijr} \leq 6 \\ 0 & f_{ijr} \leq 0 \text{ or } f_{ijr} > 6 \end{cases}$$

And gray rating function

$$X_{ijr} = \varphi x(f_{ij1}) + \varphi x(f_{ij2}) + \dots + \varphi x(f_{ijm})$$

From analysis we got,  $X_{114} = 2, X_{124} = 0, X_{134} = 11/3, X_{144} = 0, X_{214} = 10/3, X_{224} = 3, X_{234} = 3, X_{244} = 10/3, X_{254} = 11/3, X_{264} = 3.$

5. Through the fifth gray function:

$$\varphi 5(f_{ijr}) = \begin{cases} 1 & 0 < f_{ijr} < 1 \\ 2 - f_{ijr} & 1 \leq f_{ijr} \leq 2 \\ 0 & f_{ijr} \leq 0 \text{ or } f_{ijr} > 2 \end{cases}$$

And gray rating function

$$X_{ijr} = \varphi x(f_{ij1}) + \varphi x(f_{ij2}) + \dots + \varphi x(f_{ijm})$$

From analysis we got,  $X_{115} = 0, X_{125} = 0, X_{135} = 0, X_{145} = 0, X_{215} = 0, X_{225} = 0, X_{235} = 0, X_{245} = 0, X_{255} = 0, X_{265} = 0.$

6. Calculate the gray evaluation weight vector and weight matrix of the country’s dike form are given by [2, 7, 8]

$$X_{11} = \sum_{\epsilon=1}^5 X_{11\epsilon} = X_{111} + X_{112} + X_{113} + X_{114} + X_{115} = 13.549,$$

Similarly,

$$X_{12} = 11.425, X_{13} = 15.286, X_{14} = 11.196.$$

So the matrix  $R_1$  is formed as:

$$R_1 = \begin{bmatrix} 0.2788 & 0.3374 & 0.2362 & 0.1476 & 0 \\ 0.3598 & 0.4126 & 0.2276 & 0 & 0 \\ 0.2181 & 0.2804 & 0.2617 & 0.2399 & 0 \\ 0.3771 & 0.4083 & 0.2144 & 0 & 0 \end{bmatrix}$$

Similarly,

$$X_{21} = 13.883, X_{22} = 14.727, X_{23} = 13.495, X_{24} = 11.959, \\ X_{25} = 14.670, X_{26} = 14.511.$$

So the matrix  $R_2$  is formed as

$$R_2 = \begin{bmatrix} 0.2001 & 0.2572 & 0.3025 & 0.2401 & 0 \\ 0.2414 & 0.3104 & 0.2444 & 0.2037 & 0 \\ 0.1976 & 0.2541 & 0.3260 & 0.2223 & 0 \\ 0.1765 & 0.2270 & 0.3178 & 0.2787 & 0 \\ 0.1969 & 0.2532 & 0.2999 & 0.2499 & 0 \\ 0.2144 & 0.2757 & 0.3032 & 0.2067 & 0 \end{bmatrix}$$

Similarly, the calculation of the packet direct mail mode is as follows:

$$X_{1i} = [ 11.3175 \ 11.6032 \ 10.7301 \ 12.0063 ]^T (i = 1, 2, 3, 4)$$

$$X_{2j} = [ 12.4126 \ 12.2921 \ 11.3714 \ 12.6540 \ 12.1714 \ 12.5651 ]^T (j = 1, 2, 3, 4, 5, 6)$$

$$R_1 = \begin{bmatrix} 0.3436 & 0.3913 & 0.2651 & 0 & 0 \\ 0.3352 & 0.4063 & 0.2584 & 0 & 0 \\ 0.4126 & 0.3994 & 0.1864 & 0 & 0 \\ 0.2869 & 0.3689 & 0.3165 & 0.0278 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.1790 & 0.2302 & 0.3223 & 0.2685 & 0 \\ 0.1717 & 0.2208 & 0.3091 & 0.2983 & 0 \\ 0.3518 & 0.4020 & 0.2462 & 0 & 0 \\ 0.1932 & 0.2484 & 0.3477 & 0.2107 & 0 \\ 0.1643 & 0.2113 & 0.2958 & 0.3286 & 0 \\ 0.2564 & 0.3297 & 0.3343 & 0.0796 & 0 \end{bmatrix}$$

Calculating overseas storage:

$$X_{1i} = [ 11.1936 \ 11.9523 \ 11.1963 \ 11.8666 ]^T (i = 1, 2, 3, 4)$$

$$X_{2j} = [ 11.7746 \ 12.3365 \ 11.3714 \ 12.4953 \ 12.2540 \ 12.5333 ]^T (j = 1, 2, 3, 4, 5, 6)$$

$$R_1 = \begin{bmatrix} 0.3772 & 0.4084 & 0.2144 & 0 & 0 \\ 0.2789 & 0.3586 & 0.3347 & 0.0279 & 0 \\ 0.3579 & 0.4083 & 0.2144 & 0 & 0 \\ 0.1966 & 0.1966 & 0.3539 & 0.2528 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.3020 & 0.3640 & 0.3057 & 0.0283 & 0 \\ 0.2342 & 0.3011 & 0.3567 & 0.1081 & 0 \\ 0.3518 & 0.4020 & 0.2462 & 0 & 0 \\ 0.2134 & 0.2744 & 0.3521 & 0.1601 & 0 \\ 0.1995 & 0.2565 & 0.3264 & 0.2176 & 0 \\ 0.1862 & 0.2394 & 0.3351 & 0.2394 & 0 \end{bmatrix}$$

The gray category calculation for international express delivery indicators is as follows:

$$B_1 = \omega_1 \times R_1 = [0.4910, 0.0706, 0.2929, 0.1454]^T$$

$$\begin{aligned} & \times \begin{bmatrix} 0.2788 & 0.3374 & 0.2362 & 0.1476 & 0 \\ 0.3598 & 0.4126 & 0.2276 & 0 & 0 \\ 0.2181 & 0.2804 & 0.2617 & 0.2399 & 0 \\ 0.3771 & 0.4083 & 0.2144 & 0 & 0 \end{bmatrix} \\ & = [0.2810 \ 0.3363 \ 0.2399 \ 0.1427 \ 0] \end{aligned}$$

$$B_2 = \omega_2 \times R_2 = [0.1584, 0.1892, 0.1908, 0.0483, 0.1502, 0.2558]^T$$

$$\begin{aligned} & \times \begin{bmatrix} 0.2001 & 0.2572 & 0.3025 & 0.2401 & 0 \\ 0.2414 & 0.3104 & 0.2444 & 0.2037 & 0 \\ 0.1976 & 0.2541 & 0.3260 & 0.2223 & 0 \\ 0.1765 & 0.2270 & 0.3178 & 0.2787 & 0 \\ 0.1969 & 0.2532 & 0.2999 & 0.2499 & 0 \\ 0.2144 & 0.2757 & 0.3032 & 0.2067 & 0 \end{bmatrix} \end{aligned}$$

$$= [0.2080 \ 0.2675 \ 0.2943 \ 0.2229 \ 0]$$

The calculation of the secondary indicators for direct mail parcels is as follows:

$$B_1 = \omega_1 \times R_1 = [0.4910, 0.0706, 0.2929, 0.1454]^T$$

$$\times \begin{bmatrix} 0.3436 & 0.3913 & 0.2651 & 0 & 0 \\ 0.3352 & 0.4063 & 0.2584 & 0 & 0 \\ 0.4126 & 0.3994 & 0.1864 & 0 & 0 \\ 0.2869 & 0.3689 & 0.3165 & 0.0278 & 0 \end{bmatrix}$$

$$= [0.3549 \ 0.3914 \ 0.2490 \ 0.0040 \ 0]$$

$$B_2 = \omega_2 \times R_2 = [0.1584, 0.1892, 0.1908, 0.0483, 0.1502, 0.2558]^T$$

$$\times \begin{bmatrix} 0.1790 & 0.2302 & 0.3223 & 0.2685 & 0 \\ 0.1717 & 0.2208 & 0.3091 & 0.2983 & 0 \\ 0.3518 & 0.4020 & 0.2462 & 0 & 0 \\ 0.1932 & 0.2484 & 0.3477 & 0.2107 & 0 \\ 0.1643 & 0.2113 & 0.2958 & 0.3286 & 0 \\ 0.2564 & 0.3297 & 0.3343 & 0.0796 & 0 \end{bmatrix}$$

$$= [0.2276 \ 0.283 \ 0 \ 0.3032 \ 0.1789 \ 0]$$

The overseas storage calculation is as follows:

$$B_1 = \omega_1 \times R_1 = [0.4910, 0.0706, 0.2929, 0.1454]^T$$

$$\times \begin{bmatrix} 0.3772 & 0.4084 & 0.2144 & 0 & 0 \\ 0.2789 & 0.3586 & 0.3347 & 0.0279 & 0 \\ 0.3579 & 0.4083 & 0.2144 & 0 & 0 \\ 0.1966 & 0.1966 & 0.3539 & 0.2528 & 0 \end{bmatrix}$$

$$= [0.3383 \ 0.3740 \ 0.2432 \ 0.0387 \ 0]$$

$$B_2 = \omega_2 \times R_2 = [0.1584, 0.1892, 0.1908, 0.0483, 0.1502, 0.2558]^T$$

$$\times \begin{bmatrix} 0.3020 & 0.3640 & 0.3057 & 0.0283 & 0 \\ 0.2342 & 0.3011 & 0.3567 & 0.1081 & 0 \\ 0.3518 & 0.4020 & 0.2462 & 0 & 0 \\ 0.2134 & 0.2744 & 0.3521 & 0.1601 & 0 \\ 0.1995 & 0.2565 & 0.3264 & 0.2176 & 0 \\ 0.1862 & 0.2394 & 0.3351 & 0.2394 & 0 \end{bmatrix}$$

$$= [0.2472 \ 0.3043 \ 0.3146 \ 0.1266 \ 0]$$

International Express Score Vector is

$$\begin{aligned}
 H_1 &= \omega \times R = [0.25 \ 0.75] \times \begin{bmatrix} 0.2810 & 0.3363 & 0.2399 & 0.1427 & 0 \\ 0.2080 & 0.2675 & 0.2943 & 0.2229 & 0 \end{bmatrix} \\
 &= [0.2263 \ 0.2847 \ 0.2807 \ 0.2028 \ 0]
 \end{aligned}$$

Parcel direct mail score vector is

$$\begin{aligned}
 H_2 &= \omega \times R = [0.25 \ 0.75] \times \begin{bmatrix} 0.3549 & 0.3914 & 0.2490 & 0.0040 & 0 \\ 0.2276 & 0.2830 & 0.3032 & 0.1789 & 0 \end{bmatrix} \\
 &= [0.2594 \ 0.3101 \ 0.2897 \ 0.1352 \ 0]
 \end{aligned}$$

Overseas storage score vector is

$$\begin{aligned}
 H_3 &= \omega \times R = [0.25 \ 0.75] \times \begin{bmatrix} 0.3383 & 0.3740 & 0.2432 & 0.0387 & 0 \\ 0.2472 & 0.3043 & 0.3146 & 0.1266 & 0 \end{bmatrix} \\
 &= [0.2700 \ 0.3217 \ 0.2968 \ 0.1046 \ 0]
 \end{aligned}$$

Convert rating values to vectors C, C = [9, 7, 5, 3, 1].

AHP process designed by Satty and Vargas [9] have been followed for analytical hierarchy. It has been found the weight value of the overseas warehousing and distribution model (Z<sub>1</sub>), parcel direct mail (Z<sub>2</sub>) and international express delivery (Z<sub>3</sub>) are given by:

$$\begin{aligned}
 Z_1 &= H_1 C^T = [0.2594 \ 0.3101 \ 0.2897 \ 0.1352 \ 0] \times [9 \ 7 \ 5 \ 3 \ 1]^T = 6.0451 \\
 Z_2 &= H_2 C^T = [0.2263 \ 0.2847 \ 0.2807 \ 0.2028 \ 0] \times [9 \ 7 \ 5 \ 3 \ 1]^T = 6.3594 \\
 Z_3 &= H_3 C^T = [0.2700 \ 0.3217 \ 0.2968 \ 0.1046 \ 0] \times [9 \ 7 \ 5 \ 3 \ 1]^T = 6.4797
 \end{aligned}$$

## 4 Result and Discussion

According to the above results, Z<sub>1</sub> = 6.0451, Z<sub>2</sub> = 6.3594, and Z<sub>3</sub> = 6.4797. Where Z<sub>1</sub> < Z<sub>2</sub> < Z<sub>3</sub>. It can be concluded that the overseas warehousing and distribution model has the highest comprehensive score, followed by parcel direct mail and finally international express delivery. The results are related to the selection of the Lemon Company’s cross-border export e-commerce logistics distribution model.

Based on the previous indexing system construction and the results obtained by using the analytic hierarchy process and gray correlation method, a comprehensive evaluation of the current logistics and distribution model existing in the cross-border e-commerce of Lemon Company have been done at strategic and tactical level. Among the cross-border e-commerce logistics distribution models, the company prefers overseas warehousing and distribution models.

Overseas warehousing is characterized by fast turnover and one-stop sorting, packaging, and distribution functions, which also meets the company's current main export product needs. Therefore, in terms of the long-term development of Lemon Company, it can increase its choice of overseas warehousing and distribution models. The development of Lemon Company's overseas warehousing model can also solve the existing problems of Lemon Company's logistics:

#### ***4.1 Overtime Distribution of Logistics***

The overseas warehousing distribution mode can greatly reduce the logistical delivery time of Lemon Company. At present, most of Lemon Company's distribution mode is completed by international postal parcels, and it takes around 13–15 days. With the overseas storage mode, the goods can be delivered to customers in a maximum of 3 working days, which can improve the customer's satisfaction to Lemon Company's products to a certain extent.

#### ***4.2 Solve the Problem of Return***

The overseas warehousing and distribution model can solve the problem of customers wanting to return products due to quality and other issues. Its existence would allow customers to return the goods directly to overseas warehouses, without the need of a series of complicated procedures such as customs clearance. It will also reduce the customer's burden on return costs which indirectly improves the service quality of Lemon Company. In the distribution process, the number of turnovers of the goods is also reduced, thereby reducing the damage rate of the goods packaging and the like, which can reduce the return rate of the goods.

#### ***4.3 Reduce Logistics Costs***

Some of the fast selling goods such as some towels, soaps Can be stored in overseas warehouses and distribute it in batches, so that its average logistics cost will be reduced, hence the same product can be prevented from being sent frequently. Customs clearance and other steps can also be avoided. At present, Lemon Company uses the international express logistics distribution mode for the delivering the fast-selling products. In this method the logistics cost of small quantity will be higher than its own value.

## 5 Conclusion

Lemon's Company existing cross-border e-commerce logistics distribution model, overseas storage, international postal parcels and international courier, relies too much on direct postal parcel and direct mail which limits the development of Lemon company to a certain extent. Through model construction and analysis result, it shows that this company will be benefited through overseas storage model. This type of model can also be an example for other such companies. With the rapid development of cross-border e-commerce, more logistics distribution modes may appear. Lemon may need to recalculate the choice when selecting the cross-border e-commerce logistics distribution mode or may even look into advanced technological based logistics solutions such as those using developments like Blockchain [10].

## References

1. B. Chen, Empirical study on cross border e-commerce enterprise logistics model under the background of economic globalization. *Rev. Fac. Ing.* **32**(12) (2017)
2. A. Yadav, M. Ali, M. Aris, S. Tuladhar, The analytical hierarchy process (AHP) approach for assessment of tax and revenue for Nepal. *Int. J. Curr. Res. (IJCR)* **7**(5), 15891–15896 (2015)
3. F. Ji, X.H. Zang, Innovation and development trend of cross-border e-commerce logistics. *China Bus. Market* **29**(6) (2015)
4. A. Yadav, M. Anis, M. Ali, S. Tuladhar, Analytical hierarchy process (AHP) for analysis: selection of passenger airlines for Gulf country. *Int. J. Sci. Eng. Res.* **6**(3), 379–389 (2015)
5. A. Yadav, G. Bhandari, D. Ergu, M. Ali, M. Anis, Supplier selection by AHP in KMC pharmaceutical: use of GMIBM method for inconsistency adjustment. *J. Manage. Res.* **7**(5), 19–46 (2015)
6. M. Ali, A. Yadav, M. Anis, Assessment of hazardous waste management proposal: using the analytic hierarchy process. *Int. J. Econ. Comm. Manage.* **3**(7), 315–327 (2015)
7. J. Pérez, Some comments on Saaty's AHP. *Manage. Sci.* **41**(6), 1091–1095 (1995)
8. Y. Su, Y. Wang, C. Mim, The forecast of development prospects of China's cross-border E-commerce based on grey system theory, in *2017 International Conference on Grey Systems and Intelligent Services (GSIS)* (IEEE, 2017, August), pp. 182–186
9. T.L. Saaty, L.G. Vargas, *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*, vol 175 (Springer Science & Business Media, Berlin, 2012)
10. R.R. Vokerla, B. Shanmugam, S. Azam, A. Karim, F.D. Boer, M. Jonkman, F. Faisal, An overview of blockchain applications and attacks, in *2019 International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN)* (2019)