Study on Cross-Border E-Commerce Logistics Optimization Platform based on Big Data

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Abstract

The continuous development of computer and Internet technologies has brought great changes and benefits to various businesses and driven the development of logistic enterprises, among which, big data technology has played an important role in building cross-border e-commerce logistics information networks. Based on the big data processing technology, this paper analyzes all parts of the cross-border e-commerce logistics process, builds a standardized modular logistics optimization platform and takes a logistics network as an example to verify its effectiveness so as to provide references and guidance for the further improvement of cross-border e-commerce logistics technologies.

Keywords: big data, cross-border e-commerce, logistics optimization platform, modular.

1. INTRODUCTION

Nowadays, while technologies like computers, the Internet and mobile terminals are being improved and upgraded, they grow increasingly popular among ordinary people and become an integral part of people’s life and work. Whenever people use them, whether on computer or the mobile terminal, the network will automatically generate data, which together constitute an enormous amount. Now these data are also becoming the development platform for different businesses to pursue their interests (Guo, 2014) and one of the main driving forces to the development of information technology.

Information development drives the rapid development of cross-border e-commerce (Sun et al., 2013), but in the process, cross-border e-commerce also faces a lot of issues in logistics, such as the slow speed and high costs of logistics, difficulties in product return and exchange and restrictions in after-sales services, etc. (Yang et al., 2014); therefore, we should work on how to solve these issues in order to facilitate the smooth development of cross-border e-commerce. Scholars have studied various ways of logistics distribution, including integrated logistics (Paulraj and Chen, 2007), logistics distribution by physical stores (Ye et al., 2008), self-support logistics distribution (Mao and Yang, 2012), logistics alliance (Liu et al., 2009), fourth-party distribution (Li et al., 2012) and third-party distribution (Stanton, 2013), etc. The logistic performance also depends on how many areas in which information technology is applied, including the whole industry chain of cross-border e-commerce (Lee et al., 2011), various nodes in the logistic process (Shui et al., 2010), synergy between different organizations (Wang et al., 2015), logistic routes (Alshamrani et al., 2007) and costing (Cheng et al., 2009), etc., because information technology can improve the logistic speed and efficiency (Schuldt et al., 2010). As a result, computer technologies like cloud computing and big data are gradually applied in the logistic field (Waller and Fawcett, 2013; Zhong et al., 2015; Ayed et al., 2015).

The data of cross-border e-commerce logistics organizations come from both online and offline. The big data technology has played an important role in building cross-border e-commerce logistics information networks (Wang et al., 2015). Based on the big data processing technology, this paper analyzes all parts of the cross-border e-commerce logistics process, builds a standardized modular logistics optimization platform and takes one of Alibaba’s logistics networks as an example to verify its effectiveness so as to provide references and guidance for the further improvement of cross-border e-commerce logistics technologies.

2. BIG DATA TECHNOLOGY
Every day, tremendous amounts of data are produced on PCs, mobile terminals and data acquisition equipment through the Internet. Therefore, people use the big data technology to acquire, store, exploit, manage, analyze and apply these data to obtain the data and information they need for the purposes of increasing commercial values and improving the management services on the client side (Neaga et al., 2015).

The characteristics of big data can be described with 5V’s – Volume, Velocity, Variety, Value and Veracity. And data processing involves data analysis and cloud computing, etc. The big data technology is to find and obtain values by analyzing data. To be more specific, it is to compute and analyze a big volume of complex, constantly changing, authentic and valid data, find the correlations among them and obtain the information that is useful or relevant to decision making. In this process, data analysis is performed to analyze the data pattern and understand how to better use these data, predict what may happen in the future based on the existing data and test the validity of the data, etc.

3. CHARACTERISTICS OF CROSS-BORDER E-COMMERCE LOGISTICS BASED ON BIG DATA

Through the cross-border e-commerce logistics information platform built on big data technology, people can collect various logistics information and achieve information sharing, including customer needs and logistic resources, etc. and then conduct logistics coordination for logistic companies, routes, warehouses and transfer stations through the cloud computing application on the platform to coordinate social logistic resources in a rational and quick manner, reduce costs and provide convenient, fast, effective and flexible logistic services for customers. The specific operation framework is shown in Figure 1.

The big-data-based logistics platform can improve the traditional logistic operations. For directly delivered articles, the cloud platform can achieve information exchanges between sellers and customers, provide optimized logistic solutions according to the needs of different parties and accumulated data, and make real-time changes in customers’ logistic needs. For logistics and courier delivery companies, the cloud platform can calculate the most convenient, efficient and cost-effective way of transport and route through data analysis of such information as cost and traffic conditions. Regarding the site selection for physical stores and warehouses of cross-border e-commerce, the big data cloud platform can find the ideal areas for commodity sales based on previous transaction information and data and estimate the sales so that merchants can stock appropriate quantities of goods in their physical stores or warehouses in advance, and in this way, their commodity supply and transport efficiency can also be improved. The specific process is shown in Figure 2.

Figure 1. Logistics Operation Process based on Big Data Logistics Information Platform
4. BIG-DATA-BASED MODULAR LOGISTICS OPTIMIZATION PLATFORM FOR CROSS-BORDER E-COMMERCE

4.1 Modularization of logistics

It can be seen from Figure 1 that in the whole logistic information process, all parts are mutually independent but also closely connected to each other; therefore, this process can be divided into several modules. Each module does their own job, develops their own processes, systems or rules, strictly follows them and at the same time pays great attention to the interfaces between modules. In this way, the logistic execution efficiency and service level will be improved.

The cross-border e-commerce logistics service process can be divided into 6 modules, namely storage, courier delivery, distribution, cross-border operations, value-added services and consulting.

The storage module can be further divided into general storage and refrigerated storage, etc. by commodity type.

In the courier module, the goods to be delivered should be sorted, including general goods and special goods like cold-chain and fragile goods, etc.; by geographic location, deliveries can be divided into international and domestic express deliveries.

The distribution module mainly serves different customers’ needs in receiving goods, including home delivery, self-pickup, goods receiving boxes, community goods receiving services and courier station receiving services, etc.

The cross-border operations module is very important to cross-border e-commerce operations, which covers customs clearance, foreign exchange settlement and tax management required in export and import.

The value-added services module mainly covers other services related to logistics, including delivery insurance, payment by installments and bill-paying services.

The consulting module is the consulting platform for the whole logistic process. Users can ask any question or offer any suggestion on logistics by telephone or through the network consulting platform.

By modularizing the logistic process, people can make best use of the functions in each part and then integrate different modules with the big data technology to coordinate the operations between modules and improve work efficiency.

4.2 Cross-border e-commerce logistics method selection model

By considering the impacts of transaction costs on the selection of logistics methods, we build a mathematic model. Let’s suppose there are only 2 companies – A and B are carrying out cross-border e-commerce logistic
activities X and Y on the platform, both with an efficiency of k: Company A is good at doing Activity X while B good at Activity Y. Let \( x' \) and \( y' \) respectively represent the volumes of Activity X and Y output by Company A, \( x_A \) and \( y_A \) respectively represent the volumes of Activity X and Y given by Company A to support itself and \( x'_A \) and \( y'_A \) be the volumes of Activity X and Y supplied by Company A to others. Let \( a_{Ax} \) and \( a_{Ay} \) represent the competencies of Company A in Activity X and Y respectively and \( l_{Ax} \) and \( l_{Ay} \) represent the manpower invested in Activity X and Y. The utility maximization functions for Company A and B can be expressed as follows:

\[
\begin{align*}
\max U_A &= (x_A + kx'_A)^\theta \left( y_A + ky'_A \right)^{1-\theta} \\
\max U_B &= (x_B + kx'_B)^\theta \left( y_B + ky'_B \right)^{1-\theta}
\end{align*}
\]

(1) (2)

By considering the booking terms of Company A and B, we can deduce three logistic organizational forms for Company A: (x/y): Company A only carries out Activity X and Company B only carries out Activity Y, and Product X is exchanged completely through market transactions; (xy/y): Company A can only acquire Product B by buying it from Company B, and the two companies have signed fixed trading contracts. Similarly, Company B also has these three organizational forms. Therefore, together there are 5 organizational forms for these two companies, as listed in Table 1. In order to find out which is the optimal organization form, we calculate and compare the utility and price levels of different forms, as shown in Table 1.

<table>
<thead>
<tr>
<th>Organizational Form</th>
<th>Utility Level Company A</th>
<th>Utility Level Company B</th>
<th>Price Level ( P = \frac{P_x}{P_y} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x/y)-(x/y)</td>
<td>( U_A = (\theta a_{ax})^\theta \left[ (1-\theta) a_{ay} \right]^{1-\theta} )</td>
<td>( U_B = (\beta a_{bx})^\beta \left[ (1-\beta) a_{by} \right]^{1-\beta} )</td>
<td>( l )</td>
</tr>
<tr>
<td>(xy/y)-(xy/x)</td>
<td>( U_A = a_{ay} \cdot U' )</td>
<td>( U_B = a_{by} \cdot U' )</td>
<td>( p = \frac{a_{ay}}{a_{bx}} / k a_{bx} )</td>
</tr>
<tr>
<td>(xy/y)-(y/x)</td>
<td>( U_A = a_{ax} \cdot U_B )</td>
<td>( U_B = a_{by} \cdot U_A )</td>
<td>( a_{ax} / k a_{ax} )</td>
</tr>
<tr>
<td>(xy)-(x/y)</td>
<td>( \left( k a_{by} / p a_{bx} \right)^\theta \cdot U_A )</td>
<td>( \left( k a_{by} / p a_{bx} \right)^\theta \cdot U_B )</td>
<td>( k a_{by} / a_{bx} )</td>
</tr>
<tr>
<td>(x/y)-(y/x)</td>
<td>( \left( k a_{by} / p a_{bx} \right)^{1-\theta} \cdot U_A )</td>
<td>( \left( k a_{by} / p a_{bx} \right)^{1-\theta} \cdot U_B )</td>
<td>( a_{bx} / (1-\beta) a_{ax} )</td>
</tr>
</tbody>
</table>

For the (xy/y)-(y/x) form, the sufficient condition is that both the two companies have the maximum utilities in this form. So Company A should satisfy the following relation:

\[
U_A \geq \left( k a_{by} / a_{bx} \right)^{1-\theta} \cdot U_A
\]

(3)

Substitute the equation \( p = a_{sx} / k a_{sx} \) into the relational expression, and we can obtain:

\[
k > \left( a_{sy} a_{ax} / a_{sx} a_{bx} \right)^{1/2}
\]

(4)

Company B should satisfy the following relation:

\[
U_B < \left( k a_{by} / p a_{bx} \right)^\theta \cdot U_B
\]

(5)

Substitute the equation \( P = k a_{by} / k a_{bx} \) into the relational expression, and we can also obtain formula (4).
Table 2 Balanced Structure for Different Organizational Forms of Transaction Costs

<table>
<thead>
<tr>
<th>Transaction efficiency</th>
<th>( k &lt; k_0 )</th>
<th>( k = k_0 )</th>
<th>( k &gt; k_0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced structure</td>
<td>((xy))</td>
<td>((xy))</td>
<td>((xy))</td>
</tr>
<tr>
<td></td>
<td>((xy))</td>
<td>((xy/x))</td>
<td>((xy/y))</td>
</tr>
<tr>
<td></td>
<td>((xy/y))</td>
<td>((xy/x))</td>
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<tr>
<td></td>
<td>((xy/y))</td>
<td>((xy/x))</td>
<td>((xy/y))</td>
</tr>
</tbody>
</table>

Considering the balanced condition \( M_A x_A^* = M_B x_B^* \), we can obtain the value range of \( k \), as shown in Table 2. Similarly, we obtain the balanced structures for other forms, as shown in Table 2.

It can be seen from Table 2 that, when the transaction efficiency is slow, the balanced structure for companies is usually hierarchical; when the transaction efficiency is increased to \( k_0 \), the balanced structure will be \((xy/y)-(xy/x)\); and if the transaction efficiency is further increased to \( k_A \) or \( k_B \), it will be the marketized form.

To sum up, for different transaction costs, there will be different logistic organizational forms. If the logistic costs are high, the balanced structure will be hierarchical; if the costs are low, the balanced structure will be a marketized form; and if the costs are moderate, the balanced structure will be a modularized form, which will be the optimal form for large-scale logistic services.

5. CASE ANALYSIS OF CROSS-BORDER E-COMMERCE LOGISTICS OPTIMIZATION PLATFORM

This paper takes an internet company under the Alibaba Group as an example to analyze the big-data-based modularized logistic optimization system for cross-border e-commerce. This company has built two network systems using the big data technology. One is used to achieve data sharing between cross-border e-commerce merchants, logistic companies and consumers and analyze products, historical sales data and customer needs, forecast future sales trends and storage amount and coordinate different logistic parts to make sure there is no loophole or error. The other system is a warehousing system network that covers different areas including foreign areas and includes warehousing services provided by cooperative partners. This network can greatly improve distribution efficiency and guarantee product quality. These two systems work together, controlling the overall cross-border e-commerce logistic operations in the company.

This company applies big data in the following areas on the cross-border e-commerce logistics optimization platform, as shown in Figure 3:

![Figure 3. Logistic Service based on Big Data](image-url)
This network is modularized. Different cross-border e-commerce merchants can use different logistic services on this big-data-based logistics information platform. In the storage and distribution modules, there are various warehousing and distribution companies. E-commerce merchants can choose appropriate vendors to provide the warehousing and distribution services for them according to their product types and natures; and in the cross-border operation module, there are import and export services. In each module, there are specific standards, and in the whole network, there are also common rules. All cooperative partners in this network should strictly follow these standards and rules to ensure efficient and coordinated logistic services.

6. CONCLUSION

Based on the big data processing technology, this paper analyzes all parts of the cross-border e-commerce logistics process, builds a standardized modular logistics optimization platform and takes one of Alibaba’s logistics networks as an example to verify its effectiveness, and at last draws the following conclusions:

(1) By analyzing and comparing the big-data-based logistics information platforms, we have found that the big-data-based cross-border e-commerce logistics optimization platform can greatly improve logistics service efficiency and level, which is by far the best logistics service form;

(2) We have built a mathematical model based on transaction costs and found that a modularized logistics optimization platform based on big data for cross-border e-commerce is the optimal solution for large-scale logistic services.

(3) The case analysis of the network system used by a network logistics company proves that the modularized logistics optimization platform based on big data for cross-border e-commerce is effective, convenient and rational.

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