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An Analysis of the Influencing Factors of the End of City Logistics Distribution on the Base of Interpretive Structural Model

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Abstract

E-commerce has a rapid development with the advent of the Internet era, the era of "Internet +" also let many industries to find new opportunities. Now online shopping has become a mainstream to meet the needs of people's life, especially in the developed cities, more and more people are willing to buy all sorts of goods in e - Bay, Amazon, Sunning, JD and other large e-commerce enterprises. Business enterprise needs to deliver intact goods quickly to customers to improve customers' intention of purchasing. So the development of e-commerce and express industry is closely linked. The end of the city logistics needs to contact with consumers directly as the last part of the whole process in normal logistics distribution, which may occur some problems about the damage of goods, slow information feedback, service quality and other issues will reduce the satisfaction of consumers and affect reputation of companies. This article use ISM technology to analyze the influencing factors of the logistics of the ecommerce enterprise from the perspective of consumers, and divide all of the factors into three levels, each level contains different meanings which make a reference for the trend of development of the end of city logistics distribution.

Keywords: ISM, city logistics, influencing factors

1. Introduction

In the era of big data, there are huge commercial values behind the data accumulated in the end of city logistics. Since the end of the logistics distribution data directly from the consumer, making these data become an important business indicator in the consumer segment, product segmentation, channel segmentation, etc, (Li, 2014) which is very important for the front end market forecast, customer satisfaction and supply chain management optimization. The end of city logistics distribution service differs from the main logistics, it does not look at long distance, large quantities of quantities, form neat cargo transportation, and on the contrary, it is used to solve different varieties and demand of integrated logistics services in the local geographical areas for users. Right now, the basic idea of "Customers First" has become a corporate culture in many logistics companies and reflected in the various logistics activities. So the research and analysis of the influence factors of the terminal logistics of e-commerce can help the business enterprise to make the correct decision direction through these factors, thus to obtain more customer groups.

As for the patterns, the end of city logistics distribution can be divided into three types in China. (Cai, 2014).

(1) Joint distribution mode. A number of logistics enterprises band together to make concentrate area distribution for many users, which can save social resources by focusing on centralized advantage greatly. At present, Germany, Japan, Monaco and the countries of the enterprises obtain the very good returns in this way.

(2) Convenience store cooperation model. Enterprises set up self-service deposit and form logistics cooperation with convenience stores. A lot of enterprises of the United States, Britain and other countries use this way to apply to their own logistics systems.

(3) Self setting logistics center mode. Enterprises do not rely on other institutions, but establishing extensive logistics centers. The typical representative of this model is the Amazon Co, it has been established nearly 100 large logistics centers in the United States, covering the major densely populated cities in U.S and ensuring the timely delivery, which allows 31% of U.S. users can receive the goods in the same day.

At present, many Chinese e-commerce enterprises pay little attention to the end of the logistics distribution, and there are many factors that affect the distribution in different degrees. It has been a worthy topic to find out the key factor. Commodity delivery has become the bottleneck of goods sales in many large and medium-sized cities in China. (Lan & Wang, 2011) There are also many scholars have a lot of original research on the end of city logistics of ecommerce in China.

Junsheng He and Hao Shi (He & Shi, 2013) pointed out the importance of delivery speed, and use the genetic algorithm to make a distribution path optimization model; Ning Lei (Lei, The difficulties and countermeasures of the end of E-commerce logistics, 2014) pointed out that the current plight and causes of China e-commerce logistics terminal faced, and respectively puts forward the countermeasures of the end of city and countryside logistics; Yibo Liu (Liu, 2016) uses the analytic hierarchy process to design the last kilometer logistics risk index system from different dimensions, and points out that the "environmental risk" is the key to the risk of terminal distribution logistics; Professor Boxiong Lan (Lan & Wang, 2011) points out that there are three characteristics at the end of the city logistics service system in China:

(1) Enterprise virtualization. Some relevant enterprises are in dynamic alliance.

(2) The scale of resource. Ecommerce enterprises attract a large number of decentralized logistics Service Corporation to join, and realize large-scale expansion.

(3) Unified dispatch. Enterprises provide a package of services for end users.

There are many interlocking influencing factors that affect the end of city logistics distribution, (Chen, 2013) and these factors have complex relations with each other, some maybe the distribution speed or the attitude. (Lei, The difficulties and countermeasures of the end of E-commerce logistics, 2014) As these complex relations affect the end of the logistics distribution, we need to find these constraints from the customer's point of view and adjust the future direction of the development of city logistics. So this paper firstly introduces the ISM model, which can solve the problem of the qualitative analysis. Then through the collection and analysis of the actual literature, we find out 14 factors influencing the end of logistics distribution, at last using the ISM technology to draw the progressive relationship diagram, and explain the relationship between factors and find out the deep-level factors.

2. The Theory of ISM Technology

2.1 The Introduction of ISM Technology

ISM (interpretive structural model, referred to as "ISM") is developed by J. White Felter professor in 1973, which is used to analyze the problem related with the complex social economical system, whose feature is to decompose the complex system into some subsystems, using people's practical experience and knowledge, and construct the system of a multi-lever progressive structure model with the help of computer in the end. The ISM model is an effective structure analysis method mainly based on qualitative analysis, which belongs to the concept model, using a clear chart image to express the concept of the elements in one system.

ISM belongs to the conceptual model, it can put the vague ideas and views into intuitive model and the application is very extensive. International problem such as energy issues and regional economic development, the scope of enterprises, even individual problems can apply ISM technology to build structure model. It is particularly suited to multivariable, complicated, unclear system and multi-project sequencing.

The ISM model is applied to the connection diagram to describe the relationship between system element, it generally has the following basic characteristics:

(1) The structure of the system. Nodes are used to represent the elements of system, directed edge of relationships between elements. The relationship analysis different problem with different systems, which can be understood as "impact", "depends on", "before", "need", "cause" or other meanings.

(2) ISM model is a predominantly qualitative analysis model. This model can analyze the rationality of selecting the elements of the system, and also analyze the relationship between elements and the impact on the overall system.

(3) The ISM model can be described in the form of a directed graph and a matrix. The matrix can be processed by the mathematical method of logical calculus. If we want to further study the relationship between the elements, we can combine the qualitative analysis and quantitative analysis through the calculus of matrix form, which makes the use of the ISM model be more extensive.

(4) The ISM model as a form of description of the system, just in the field of natural science and social science. It is suitable for deal with problems in complex system of social sciences and simple problems in the system with natural science as its object.

When developing or modifying a system, the first thing we need to know is relationship between elements of the system, if is the direct or indirect relations, then we can complete the task of development or reconstruction better. In this paper, we use ISM technology to analysis the influencing factors of the end of city logistics, and find out the relations between these factors.

2.2 The General Procedures of ISM Working

There are mainly seven steps when using ISM technology:

(1) Organize working group. The numbers of members in a team are generally about 10, and team members should maintain a caring attitude for the problem to be solved. To be able to ensure that people with different views into the team. Information should be sufficient, communication should be smooth.

(2) Set problem. During the preparation phase, the issue of the set must be consistent, and in the form of text to make the provisions. Members put forward the cause and reason respectively and sum up 10 to 30 factors is advisable.

(3) Choose elements. Specific the relationship between the elements, and using the arrow line to connect with each other.

(4) Name the system objectives and elements in a concise and precise language.

(5) Structure a model diagram.

(6) Make a group discussion. If the relationship between the elements and elements of the composition of the problem are both to be satisfied, then turn to the last step, or turn to the second step.

(7) Establish adjacency matrix and reachable matrix, computing, classification.

3. Establishment ISM of Influencing Factors of the End of City Logistics Distribution

3.1 Choose Key Factors of the End of City Logistics Distribution

Based on investigation and a lot of papers about logistics barriers and discussion, we find 14 factors that affect satisfaction of customers about ending logistics. The research group draws a total of 14 key factors, then code factors respectively: $S_1, S_2, ..., S_{14}$ (seen in Table 1).

Table 1. Key factors of the end of city logistics distribution

S_1	Brand reputation of logistics enterprises
S_2	Location of distribution center
S_3	Information update and feedback
S_4	Efficiency of courier delivery
S_5	Courier personnel service attitude
S_6	E-commerce enterprises' promotional activities
S_7	Labor costs
S_8	city size and urban population
S_9	Distribution of infrastructures
S_{10}	Location of collection and delivery
S_{11}	Coverage of distribution
S_{12}	Types of vehicles
S_{13}	Delivery schedule
S_{14}	The damage rate

3.2 Establishing Adjacency Matrix

In the whole system of logistics, these 14 factors are connected together, and each factor has the influence of each other. Adjacency matrix is used to describe the relationship between the system elements. The element a_{ij} of adjacency matrix can be expressed as follow:

$$a_{ij}=\begin{cases}1,\ S_iRS_j & S_i \text{ has a direct impact on the element } S_j;\\ 0,\ S_i\overline{R}S_j & S_i \text{ has no direct impact on the element } S_j;\end{cases} \quad (1)$$

Adjacency matrix describes the degree of access between two elements after the path of length 1.The element $a_{ij}=1$ of adjacency matrix on behalf of S_i has a direct impact on the element S_j. For example, $a_{12}=1$ on behalf of the location distribution center has a direct impact on the efficiency of courier delivery. According to the binary associations of elements in the system, the adjacency matrix can be described as follow:

$A =$

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S2	1	0	1	1	0	0	1	0	0	0	1	1	0	1
S3	1	0	0	1	0	0	0	0	0	0	0	0	0	0
S4	1	0	0	0	0	0	1	0	0	0	0	0	0	1
S5	1	0	0	1	0	0	0	0	0	0	0	0	0	1
S6	0	0	1	1	0	0	0	0	0	0	0	0	0	0
S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S8	0	0	0	1	0	0	0	0	0	1	1	1	1	0
S9	1	0	1	1	0	0	0	0	0	1	1	1	0	0
S10	1	0	0	1	0	0	0	0	0	0	1	1	0	0
S11	1	0	0	1	0	0	0	1	0	0	0	1	1	0
S12	0	0	0	1	0	0	1	0	0	0	0	0	1	1
S13	1	0	0	1	0	0	0	0	0	0	0	0	0	1
S14	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1. Adjacency matrix

3.3 Constructing Reachable Matrix

Reachable matrix describes the degree of access between elements after a certain length of path in a connection diagram. If S_i accesses S_k directly after length 1, and S_k accesses S_j directly after length 1, then S_i definitely accesses S_j after length 2. We can get the reachable matrix by summing up adjacency matrix A and unit matrix I and using rules of Boolean algebra for operation. In this case, we define matrix $M = A + I$, and do exponentiations to M by rules of Boolean algebra for operation. In the end, we get the reachable matrix R after four iterations.

$R =$

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14
S1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S2	1	1	1	1	0	0	1	1	0	1	1	1	1	1
S3	1	0	1	1	0	0	1	0	0	0	0	0	0	1
S4	1	0	0	1	0	0	1	0	0	0	0	0	0	1
S5	1	0	0	1	1	0	1	0	0	0	0	0	0	1
S6	1	0	1	1	0	1	1	0	0	0	0	0	0	1
S7	0	0	0	0	0	0	1	0	0	0	0	0	0	0
S8	1	0	0	1	0	0	1	1	0	1	1	1	1	1
S9	1	0	1	1	0	0	1	1	1	1	1	1	1	1
S10	1	0	0	1	0	0	1	1	0	1	1	1	1	1
S11	1	0	0	1	0	0	1	1	0	1	1	1	1	1
S12	1	0	0	1	0	0	1	0	0	0	0	1	1	1
S13	1	0	0	1	0	0	1	0	0	0	0	0	1	1
S14	1	0	0	0	0	0	0	0	0	0	0	0	0	1

Figure 2. Reachable matrix R

3.4 Connected Domain Division

According to the reachable matrix R we can obtain reachable sets $R(S_i)$, antecedent sets $A(S_i)$ and Common set $R(S_i)\cap A(S_i)$ as follows:

Table 2. First-class reachable set and antecedent set

Element	$R(S_i)$	$A(S_i)$	$R(S_i)\cap A(S_i)$
1	1	1,2,3,4,5,6,8,9,12,13,14	1
2	1,2,3,4,,7,8,12,13,14	2	2
3	1,3,4,7,14	2,3,6,9	3
4	1,4,7,14	2,3,4,5,6,8,9,12,13	4
5	1,4,5,7,14	5	5
6	1,3,4,6,7,14	6	6
7	7	2,3,4,5,6,7,8,9,12,13	7
8	1,4,7,8,12,13,14	2,8,9	8
9	1,3,4,7,8,912,13,14	9	9
10	1,4,7,8,12,13,14	2,8,9	8
11	1,4,7,8,12,13,14	2,8,9	8
12	1,4,7,12,13,14	2,8,9,12	12
13	1,4,7,13,14	2,8,9,12,13	13
14	1,14	2,3,4,5,6,7,8,9,12,13,14	14

According to the Table 2, firstly find the elements in a common set which can meet the formula $A(S_i)=R(S_i)\cap A(S_i)$:

$$T=\{S_2,S_5,S_6,S_9\} \tag{2}$$

Then find out the other elements with the same part of the former elements. If S_i and S_j are in the same set and meet the formula $R(S_i)\cap R(S_i)\neq\phi$, their reachable sets have a common unit, otherwise, they belong to two different connected domains. We can find out S_2, S_5, S_6, S_9 are in a same connected domain.

3.5 Hierarchical Division

In a multistage structure, the reachable set of the highest level elements can only be composed by itself or the strong connection elements. If S_i belongs to the highest level, it must meet the formula $R(S_i)=R(S_i)\cap A(S_i)$, we can obtain factors sets of highest level as $L(S_i)$ .According to Table 2 the first-level: $L_1=\{S_1,S_7\}$.

After finding out $L_1=\{S_1,S_7\}$, delete corresponding rows and columns from reachable matrix, get the Table 3, then continue searching for new $L(S_i)$ from the remaining reachable matrix till find out no $L(S_i)$ from each level.

Table 3. Second-class reachable set and antecedent set

Elements	$R(S_i)$	$A(S_i)$	$R(S_i)\cap A(S_i)$
2	2,3,4,,8,12,13,14	2	2
3	3,4,14	2,3,6,9	3
4	4,14	2,3,4,5,6,8,9,12,13	4
5	4,5,14	5	5
6	3,4,6,14	6	6
8	4,8,12,13,14	2,8,9	8
9	3,4,8,912,13,14	9	9

10	4,8,12,13,14	2,8,9	8
11	4,8,12,13,14	2,8,9	8
12	4,12,13,14	2,8,9,12	12
13	4,13,14	2,8,9,12,13	13
14	14	2,3,4,5,6,7,8,9,12,13,14	14

All the highest level sets founded from each level constitute $\{L(S_i)\} = \{L_1, L_2, ..., L_k\}$, then using the same method to seek out a total of 7 levels of elements:

$$L_1 = \{S_1, S_7\};\ L_2 = \{S_{14}\};\ L_3 = \{S_4\};\ L_4 = \{S_3, S_5, S_{13}\};\ L_5 = \{S_6, S_{12}\};\ L_6 = \{S_8, S_{10}, S_{11}\};\ L_7 = \{S_2, S_9\}$$

3.6 Generating Reduced Reachable Matrix

Elements in the same level and the same region can be accessed to each other is called the strongly connected blocks, which may exist in each level after the hierarchical division. For example, there are sets with strongly connected blocks such as $\{S_8, S_{10}, S_{11}\}$ exist in Fig.3.

All elements strongly connected blocks contact with each other among R' and then constitute a loop, which can be selected as a representative. In this way, we can pick S_8 to represent the rest elements, and keep elements $S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{12}, S_{13}, S_{14}$ to simplify reachable matrix R. After ordering and sorting, we can get the reduced reachable matrix R':

$$R' = \begin{array}{c} \\ S1 \\ S7 \\ S14 \\ S4 \\ S3 \\ S5 \\ S13 \\ S6 \\ S12 \\ S8 \\ S2 \\ S9 \end{array} \begin{array}{c} \begin{array}{cccccccccccc} S1 & S7 & S14 & S4 & S3 & S5 & S13 & S6 & S12 & S8 & S2 & S9 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 1 & 0 & 1 & 1 & 0 & 1 \end{bmatrix} \end{array}$$

Figure 3. Reduced reachable matrix R`

3.7 Establishing Hierarchical Structure Model

According to the conclusion from Figure 3, we can map directional hierarchy graph, and get the hierarchical structure model of the influencing factors of the end of city logistics distribution (seen in Figure 4). The main purpose of establishing hierarchical model in this paper is to better understand the progressive relationship between factors in one system. We can see that the all the factors are divided into three levels according to their influence degree on end of city logistics distribution: Surface-level factors, middle-level factors and deep-level factors.

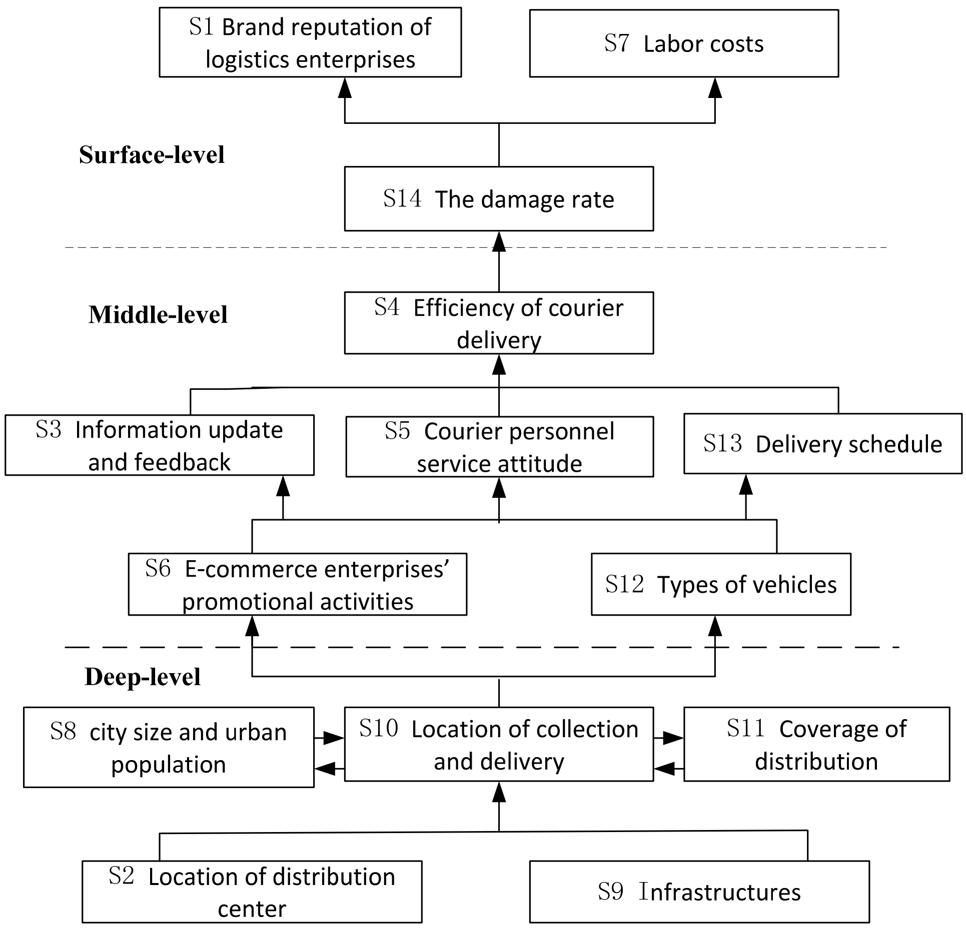

Figure 4. ISM model

The Surface-level factors include brand reputation of logistics enterprises, labor costs, damage rate. The Surface factors are mainly aimed at the "hardware" requirements of logistics enterprises. When the city size is established, enterprises should choose suitable distribution scheme to apply to different scales of cities. For example, in the crowded first-tier cities, logistics and distribution form of the use is storage cabinets. As for some sparsely populated areas, we can choose the appropriate traffic tools to increase the scope of distribution and reduce transportation costs.

The middle-level include efficiency of courier delivery, information update and feedback, courier personnel service attitude, delivery schedule, e-commerce enterprises' promotional activities, types of vehicles. These factors tend to be more "software" requirements, emphasizing the comprehensive quality of express delivery personnel and timely information. When it comes to e-commerce enterprises held more sales promotion activities, such as Chinese "double eleven" activities, it will test the logistics operation ability of many logistic companies. If there are good courier service, reasonable time arrangement and efficient delivery and timely deliver the goods, which can greatly increase the customers' satisfaction and future transactions of business and logistics enterprises. These factors affect the end of city logistics distribution from the emotional point of view.

The deep-level factors include city size and urban population, location of collection and delivery, coverage of distribution, location of distribution center, infrastructures. This is the main source of control at the development of the logistics industry. When customers go shopping from the Internet, the first thing they are concerned is if goods are intact. If e-commerce companies can cooperate with the high reputation logistics enterprises, which will give consumers a good sense of security and improve consumer purchasing intention.

Labor costs of services are the most important aspects of the business or logistics enterprises, which affect the delivery scope, personnel service and delivery efficiency to a certain extent, thereby affecting the final customer experience.

Among the three categories, deep-level factors play the most important role in the agricultural logistics distribution center location, middle-level factors play less role, and surface-level factors play the least role.

4. Conclusion

In view of the above factors in three levels of the end of city logistics distribution, we can proceed from the following aspects to optimize the distribution of the end of the logistics:

(1)Besides the e-commerce enterprises have their own logistics system, the logistics partner of the e-commerce enterprise should choose the enterprise with high reputation, and establish the supervision mechanism of the logistics evaluation. Like China's enterprises, JD and sunning, and America's enterprises, like e-bay, Amazon, they both do successfully and have a lot of high-quality customer sources.

(2)Enterprises should choose the high quality packaging which could reduce the damage to a minimum, reduce violence distribution frequency in the process of sorting, circulation and sending pieces, arrange the delivery time to compress traveling time.

(3)Logistics enterprises should allocate human resources efficiently, and improve the overall quality of staff, reduce the cost of labor services.

(4)The current situation is there are a huge number of Chinese rural areas, and China's rural purchasing potential is huge. The data show that the online shopping turnover reached 353 billion yuan in Chinese rural area in 2015, an increase of 96%. At present, agricultural product retail sales in network has been up to 150.5 billion yuan, Internet users in rural areas reached 5659 million people, the new shop reached 118 million, it has built 250 thousand electric village service stations in the 1000 counties around the whole country. (Zhu, 2012) Although the "Internet + rural" mode is just like a very attractive "cake", now the question is how to export. Home delivery service is still a huge test, if enterprises can expand the scope of distribution and offer free home delivery service, this huge cake will give e-commerce and logistics enterprises a great reward.

In this paper, we can only use experience and knowledge from the perspective of qualitative analysis of the influence factors of the end of city logistics according to ISM technology. In order to deal with the specific issues to be more accurate and practical, we should also consider the different contribution of each factor and make quantitative analysis on the basis of qualitative analysis to guarantee the accuracy of the analysis results.

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