Research on the influence of the different logistics demand structures of the city in regional logistics planning

Si Chen[1], Gan Mi[2*], Dingqi Shuai[1]

[1] *Department of Transportation, Emei Branch, Southwest Jiaotong University, Emei, Sichuan Province, China 614202*

[2] *School of Transportation and Logistics, Southwest Jiao tong University, Chengdu, Sichuan Province, China 610031*

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Abstract

This research analysis the different parts of regional logistics demand at first. There are three parts of the logistics demand considered in this paper; they are logistics demand in the city, logistics demand between cities and the logistics demand from or outside the area. The relationships have been studied by the Grey Theory, and a numerical example has been made to show the way how to analysis the logistics demand structure in the regional logistics planning. In the regional logistics, planning the difference of logistics demand structures of the cities should be fully considered. Then the logistics planning with different regional logistics planning purposes have been programmed. Based on the numerical example, different plans and different influence scopes have been got at last.

Keywords: Logistics Demand, Grey Theory, Logistics planning, Demand Structure

1 Introduction

Regional logistics planning is more about the location of the logistics distribution centres and the optimizing of the transportation network. Moreover, the location of logistics distribution centres are usual in the cities, which have strong attractive to the flow of logistics. The reason of this situation is that the most development economic centres, high-density population centres and the concentrated industry centres are all located in the cities. Since different cities with different structure of economic and industry, the logistics planning to different cities is changed with the situations of cities [1].In a city which is located in a given area, the logistics planning of this city has strong connection with the structure of the logistics demand. In addition, logistics demand is kind of derivative demand of the developing of economic and society. The regional logistics demands perform in one of cities in this area can be classified into three parts showed in Figure. 1. The first part is logistics demand for city itself, which is used to ensure the regular operation of the city. The second part of logistics demand is between cities in the area, which is. The last part is the logistics demand of communication with the outside world [2].When the three parts has been considered as three influence factors to the whole logistics demand in the city; we can analyse the relationship between the logistics demand and the influence factors by Grey Theory [3].

The grey theory, one of the methods that are used to study uncertainty, is superior in theoretical analysis of systems with imprecise information and incomplete samples [4]. Grey related degree analysis is based on the grey theory. Grey theory has become an important ingredient in the development of information processing. Grey systems-based techniques are powerful tools in addressing those systems in which information is partially known and partially unknown [5]. So based on the analyses of the influence of the different structures of the logistics demand we can program the logistics planning by the particular needs of the area. We can build local distribution centres for the logistics demand of one city or between cities in the area. And we can build logistics centre for the whole area to communicate to the outside the area. The process of logistics planning is follow the method of Analytic Hierarchy Process (AHP) [6], which is the approach to relative measurement, a scale of priorities is derived from pair wise comparison measurements only after the elements to be measured are known [7]. The method of Analytic Hierarchy Process (AHP) was developed by Thomas. Saaty [8] in the 1970s. Moreover, it is kind of a structured technique for analysing the complex decisions, which is built up based on mathematics and psychology.

In addition, in this paper we assume that the whole area is made up by cities, so we just can build logistics hubs in the selected cities but the place outside the cities. Regional logistics planning is more about the location of the logistics distribution centres and the optimizing of the transportation network. Moreover, the location of logistics distribution centres are usual in the cities, which have strong attractive to the flow of logistics. The reason of this situation is that the most development economic centres, high-density population centres and the concentrated industry centres are all located in the cities. Since different cities with different structure of economic and industry, the logistics planning to different cities is

* ***Corresponding author*** e-mail: migan@swjtu.cn

changed with the situations of cities. In a city, which is located in a given area, the logistics planning of this city has strong connection with the structure of the logistics demand. And logistics demand is kind of derivative demand of the developing of economic and society. The regional logistics demands perform in one of cities in this area can be classified into three parts showed in Figure. 1. The first part is logistics demand for city itself, which is used to ensure the regular operation of the city. The second part of logistics demand is between cities in the area, which is. The last part is the logistics demand of communication with the outside world. When we consider the three parts as three influence factors to the whole logistics demand in the city, we can analyse the relationship between the logistics demand and the influence factors by Grey Theory.

The grey theory, one of the methods that are used to study uncertainty, is superior in theoretical analysis of systems with imprecise information and incomplete samples. Grey related degree analysis is based on the grey theory. Grey theory has become an important ingredient in the development of information processing. Grey systems-based techniques are powerful tools in addressing those systems in which information is partially known and partially unknown. So based on the analyses of the influence of the different structures of the logistics demand we can program the logistics planning by the particular needs of the area. We can build local distribution centres for the logistics demand of one city or between cities in the area. In addition, we can build logistics centre for the whole area to communicate to the outside the area. The process of logistics planning is follow the method of Analytic Hierarchy Process (AHP), which is the approach to relative measurement, a scale of priorities is derived from pair wise comparison measurements only after the elements to be measured are known. The method of Analytic Hierarchy Process (AHP) was developed by Thomas. Saaty [9] in the 1970s. And it is kind of a structured technique for analysing the complex decisions, which is built up based on mathematics and psychology. Moreover, in this paper we assume that the whole area is made up by cities, so we just can build logistics hubs in the selected cities but the place outside the cities.

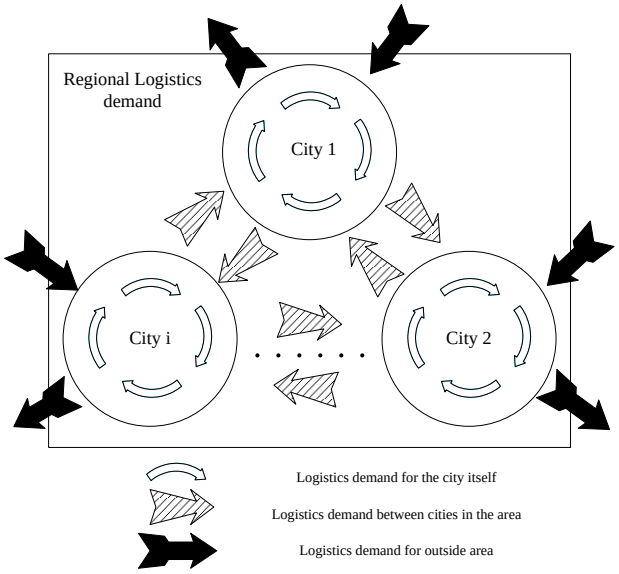

FIGURE 1 The components of Regional Logistics Demand

2 Formulation of grey related degree

In this paper, we try to calculate the grey related degree of the logistics demand and the influence factors. The characteristic sequence of system is expressed as:

$$X_0 = \left(x_0(1), x_0(2), \cdots, x_0(n)\right). \tag{1}$$

The characteristic sequence of related factors is shown as:

$$X_i = \left(x_i(1), x_i(2), \cdots, x_i(n)\right), \tag{2}$$

$$\begin{aligned} X_i D &= \left(x_i(1)d, x_i(2)d, \cdots, x_i(n)d\right) \\ &= \left(\left(x_i(1) - x_i(1)\right), \left(x_i(2) - x_i(1)\right), \cdots \left(x_i(n) - x_i(1)\right)\right) \end{aligned}$$ is remarked as:

$$X_i^0 = \left(x_i^0(1), x_i^0(2), \cdots, x_i^0(n)\right), \tag{3}$$

φ_{0i} is the related degree of the i^{th} influence factor. And $0 < \varphi_{0i} \le 1$, the bigger φ_{0i} the indication of geometric similarity closer between X_0 and X_i, or otherwise.

$$\varphi_{0i} = \frac{1 + |S_0| + |S_i|}{1 + |S_0| + |S_i| + |S_i - S_0|}. \tag{4}$$

The $|S_0|$, $|S_i|$, $|S_i - S_0|$ in the Eq. 4 are showed in the following: $|S_0| = \left|\sum_{k=2}^{n-1} x_0^0(k) + \frac{1}{2} x_0^0(n)\right|$;

$$|S_i| = \left|\sum_{k=2}^{n-1} x_i^0(k) + \frac{1}{2}x_i^0(n)\right|;$$

$$|S_i - S_0| = \left|\sum_{k=2}^{n-1}\left(x_i^0(k) - x_0^0(k)\right) + \frac{1}{2}\left(x_i^0(n) - x_0^0(n)\right)\right|.$$

φ_{0i} will be seem as the relationship between the whole logistics demand and the three parts of logistics demand. When the one of φ_{0i} is bigger than the others, the logistics demand of the city is tend to have much closer relationship with that part of logistics demand. In addition, the influence scale of logistics demand of the city will change with it too. Following this, the logistics planning will adapt the police with different ways.

In this paper we can classified the logistics demand Structures of the cities in regional logistics planning into three groups. The first structure is that the outside logistics demand is stronger than other demands. We can name it as Structure 1 (S1). The second structure is that the logistics demand between cities is much stronger than other types of logistics demands. Moreover, we name it as Structure 2 (S2). The last structure is that the logistics demand in the city is stronger than others. It is named as Structure 3 (S3). Then we can chose suitable logistics planning based on the different purposes by the different structures of cities.

3 Numerical example

In this section, we suppose there are three main cities in this area, which we studied. And we choose the data of quantity of logistics demand in ten years. We assume that the three parts of logistics demand are already known. The data are shown in following Table 1, Table 2 and Table 3.

TABLE 1 The quantity of logistics demand and influence factors of city 1

Years	1	2	3	4	5	6	7	8	9	10
The whole logistics demand	20	23	24	28	31	33	35	40	44	50
Logistics demand in city 1	10	13	14	16	18	20	22	26	30	33
Logistics demand between cities	6	3	4	3	4	10	3	6	9	10
Logistics demand outside area	4	7	6	9	9	3	10	8	5	7

TABLE 2 The quantity of logistics demand and influence factors of city 2

Years	1	2	3	4	5	6	7	8	9	10
The whole logistics demand	100	110	120	140	150	155	168	170	175	180
Logistics demand in city 2	60	61	50	40	70	40	68	58	70	70
Logistics demand between cities	20	25	35	50	55	66	80	72	85	90
Logistics demand outside area	20	24	35	50	25	49	20	10	20	20

TABLE 3 The quantity of logistics demand and influence factors of city 3

Years	1	2	3	4	5	6	7	8	9	10
The whole logistics demand	60	70	80	95	102	105	106	120	130	135
Logistics demand in city 3	25	20	21	19	15	30	23	28	15	27
Logistics demand between cities	15	20	15	16	28	5	10	12	30	8
Logistics demand outside area	20	30	44	60	60	70	73	80	95	100

According to the analysis in section 1 and 2, we can calculate the related degrees by Eq. 4, and we also can make use of the software Matlab to achieve the results. And the results are shown in Table 4.

TABLE 4 The Related Degrees of three cities

Related degrees / Cities	Related degree of Logistics demand in city i (R1)	Related degree of Logistics demand between cities (R2)	Related degree of Logistics demand outside area (R3)
City 1	0.92	0.73	0.62
City 2	0.80	0.74	0.65
City 3	0.76	0.67	0.78

From the data of Table 4, we can find that the logistics demand of City 1 has much stronger connection with the logistics demand in the city than other parts of logistics demand. Which means when we consider the logistics planning of City 1, we'd better treat City 1 as a self supply city. The logistics distribution centres should be built to meet the needs of the logistics demand in the city. And comparing the data of related degrees of logistics demand between the cities, the data of City 2 is larger than City 1 and City 3 (0.74>0.73>0.67), the logistics canters for cities in the area may be sit in or near City 2. That will be much more reasonable and good for the whole regional logistics planning.

The related degree of logistics demand in city (R1) is the maximum degree in the data of City 2, so in the three parts of logistics demand the R1 is the most important to City 2. However R1, R2 and R3 are very similar (0.8, 0.74 and 0.65), City 2 should be consider to be balance point in the area, when we try to do a regional logistics planning.

Since City 3 has the biggest related degree of logistics demand outside area between the three cities, it may be seem as the most important hub to communicate with outside area. The influence scale of City 3 may be wider

than City 1 and City 2. In the regional logistics, planning the difference of logistics demand structures of the cities should be fully considered. In one word, in this paper the structure of City 1 is S3, the structure of City 2 is S2, the structure of City 3is S1.

4 Regional logistics planning

In the process of Analytic Hierarchy Process, the project should be decomposed in to different parts and elements at first. Then the elements will be classified into different levels and different groups. The elements in the same level will be treated as the standard to the elements of next level. And in the same time the elements will be controlled by the upper level [10]. The whole hierarchy can be divided into three classes: the top level, the middle level and the lowest level. The relationship of dominance between different levels is not completed. There is an element, which not controls all the elements in the next level but part of them. The structure of the relationship of dominance is called as hierarchical structure [11].

In this paper, we consider the purpose of the Logistics planning as the top level. In this level there are three purposes, one is the logistics planning is to meet the logistics needs of outside the area, the other is to meet the logistics demand between cities in the area. And the last purpose is build logistics centres to satisfy the most needed city [12]. The middle level of this project is the demand structures of the cities.

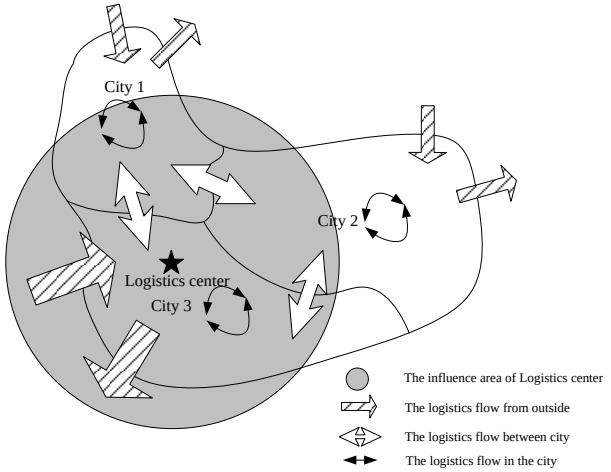

FIGURE 2 The Regional Logistics Planning for Logistics demand of outside the area

Since we consider the whole area is made up by cities, we just can build logistics hubs in the selected cities. So based on the conclusion from the section 3, we can find that if we try to optimize the regional logistics to meet the needs of logistics demand outside of the area, we can find that City 3 is the best choice of the three cities. As shown in the Figure. 2.

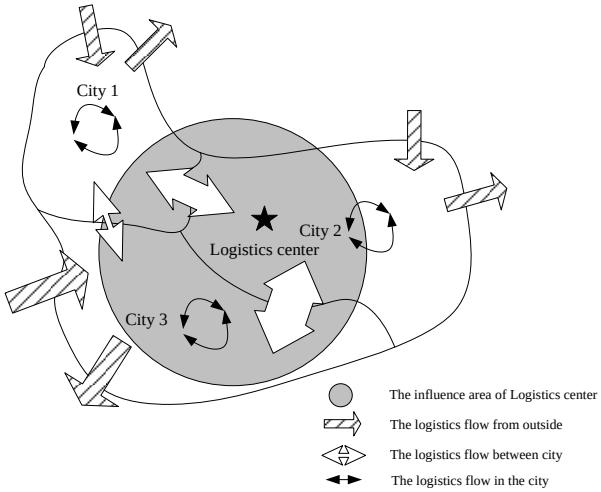

FIGURE 3 The Regional Logistics Planning for Logistics demand between cities

Because of the new Logistics Centre, which is built for the logistics demand from outside the area, the whole logistics demand flow will be attracted to the location of new logistics centre. All the logistics flows of City 3 are increased with the new logistics centre. On other hand, the flows of City 1 and City 2 decreased.

When we chose the purpose, which is to meet the logistics demand between cities in the area. We can find that City 2 has the strongest connection to other sites. When we set a new Logistics centre in City 2 to serve the logistics demand between cities, it will be much more effective than in other cities. Therefore, we can program the logistics planning with the second purpose as shown in Figure. 3.

When we compare Figure 2 with Figure 3, we can find that, the influence area of the new logistics centre with the second purpose is smaller than the influence area with the first purpose. With different purpose, the logistics planning will be changed and the standard of the logistics canter will be changed too.

If we choose the last purpose, building new logistics canters to satisfy the most needed city, we can find that City 1 is the most appropriate choice in the three cities in this paper. In this part, we suppose that we just can build one logistics canter, so we have to find out the strongest logistics demand connection for the city self in the whole logistics demand. And we can program the logistics planning with the purpose and the suggestion, mentioned above, as Figure. 4.

The logistics flow for the City 1 itself increase with the building of new logistics canter. And we also can figure out that the standard with this purpose is lower than that mentioned above. The scope of influence area is much smaller and it is limited in the City 1.

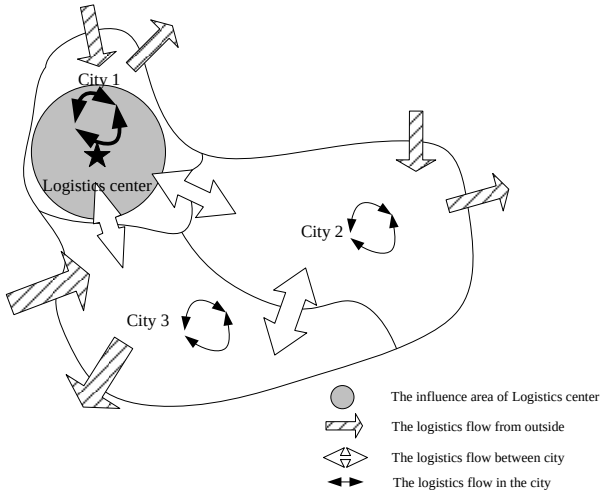

FIGURE 4 The Regional Logistics Planning to satisfy the most needed city

5 Conclusions

This study analysis the different parts of regional logistics demand at first. There are three parts we are considered in this paper, they are logistics demand in the city, logistics demand between cities and the logistics demand from or to outside the area. We study their relationships by the grey theory, and make a numerical example to show the way how to analysis the logistics demand structure in the regional logistics planning. Then we program the logistics planning with different regional logistics planning purposes. Based on the numerical example, we got different plans and different influence scopes.

Acknowledgments

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Authors

Chen Si, born in December, 1982, Chengdu

Current position, grades: assistant professor in Southwest Jiaotong University
Scientific interest: logistics management, supply chain management, transportation network optimization and logistics system optimization.
Publications: 15
Experience: Si Chen got PHD degree in Transportation planning and management from Southwest Jiaotong University in 2013. And she studied in University of Arizona from 2010 to 2011. She now is an assistant professor in Southwest Jiaotong University. Her research interests are

GanMi, born in July, 1984, Yue Yang

Current position, grades: assistant professor in Southwest Jiaotong University
Scientific interest: supply chain management, logistics network, mathematical model, transportation planning.
Experience: Mi Gan received the PHD degree in Logistics engineering from Southwest Jiaotong University in 2012. And she is an assistant professor in Southwest Jiaotong University. Her research interests are

Shuai Dingqi

Current position, grades: ideological and political counselor in Southwest Jiaotong University
Scientific interest: transportation planning, mathematical model.
Experience: Dingqi Shuai received the undergraduate degree in Southwest Jiaotong University in 2013.