Research and Application of Supply Chain Performance Evaluation Model from the Perspective of Logistics Service

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Abstract

With the current development of science and technology, people's living standards are improving, and the advent of the internet indirectly promotes the development of the logistics industry. In order to ensure smooth and order development of the logistics industry, the paper makes researches and applications on supply chain performance under the perspective of logistics services. The paper firstly interprets the relevant concepts, and combines qualitative and quantitative methods in accordance with the selection principle of supply chain index to establish supply chain performance model. At the same time, taking port logistics service for cases, the paper researches the weight of index through selecting related index in accordance with experts discussion method, establishes model by using network level analysis method, and uses Lingo software for calculation to get the accounted important degree of each index as well as liberal port, international degree, and highway transportation capacity's vital importance for logistics supply chain performance evaluation model. The second is port regional conditions, relatively unimportant conclusion is cargo handling capacity with each thousand TEU average stay time of the ship handling in port, and relevant measures in accordance with the conclusion are raised.

Keywords: supply chain; performance; Analytic Network Process

1. Introduction

Since 2015 and particularly in 2016, the development of high-tech and acceleration of technological innovations give rise to the continuous improvement of customers ' diversification demands and growing enterprise competition. The requirements for convey speed, reduction of the transporting goods cost, improvement of quality and service are getting higher and higher. Under the perspective of logistics services, the paper evaluates the performance of supply chain to implement research and application [1].

Logistics, as a part of the supply chain, has the function combining actual local condition with goods transport, goods storage, container loading and unloading and transmitting information processing in itself to implement and control records of the user's goods, services, and the transmission information to meet market demand and supply relationships [2].

The so-called supply chain is to set manufacturers, dealers, and expected customers as one connection, among which the networking structures are showing.

Logistics service is the process to meet the maximization of enterprise's benefits as well as maximum customer benefit, and to fulfill customer and logistics' routine. Of which, service includes user ordering, shipping, handling, and sending the goods to customer [3].

Supply chain management is to achieve the effective supply of goods, to reduce the burden of logistics operations on customers, to save customers more liquidity to develop enterprise's core technology, to improve operating efficiency for the entire supply chain work processes of planning, organizing, directing, coordinating and controlling, so as to meet the requirement of sending goods and commodities with the fastest speed [4]. Management process includes flow, information flow and capital flow, which can achieve resources-sharing, information-sharing, and benefit-sharing to gain the economic benefits by organically linking them.

2. Selection Principle of Supply Chain Performance Evaluation Model Indicators

Based on accuracy, feasibility, criticality and scientificiency, the requirement for principles are as follows:

I. level principle: Indicator system is divided into three levels: results level, operational level and strategic level, relating to processes and results of supply chain performance.

II. Subject principle: It shall take customers, logistics integrators and logistics service provider into consideration.

III. Satisfaction principle: In terms of the supply chain performance measurement requirements, for customers, it is to achieve customer maximum benefit; for suppliers, it is to achieve business maximum benefits.

3. Network Analytic Model for Performance Evaluation in Logistics Service Supply Chain

Analytic Network Process (ANP), a decision method combined the hierarchical level, the inner loop, mutual control at the same time with network structure, which is suitable for complex structures, was put forward by set in 1996. Analytic Network Process is a practical multiple criteria decision-making method developing from analytic hierarchy process, which can handle the complex decision-making problems with internal dependencies and external feedback. Index levels contain the result level, operational level and strategic level [5].

3.1. Selection of Evaluation Index

Based on the facts, both qualitative and quantitative indicators are established as follows:

I. Qualitative indicators. In accordance with the principle of model index level and the main principles, index can be summarized as follows.

first level indicator	subject	second level indexes	third level indexes	
results level			responding speed to customer needs	
	customer		responding capabilities to customer demand	
		customer satisfaction	on time delivery	
			product qualification ratio	
			customer complaint rate	
			service price advantage	
Operation Level	Integrators, functional service provider		market shares	
			profit increase rate	
		rofitability operation layer	Return on Investment	
			turnover rate of capital	
			logistics operation integration degree	

 Table 1. Indicator System

		rganizational Management Level	internal transaction costs of service supply chain	
			network restructuring capacity of service supply chain	
			interests fair distribution rate	
			Enterprise loyalty	
			service innovation capability	
Strategic Level			service supply chain information sharing	
			rate of timely communication of information	
		nformation management level	accurate information transmission	
			ease of information transmission	
			member of enterprise strategic match	
		laboration Capabilities	effectiveness of incentive mechanism	
		nuooranon Capaonnies	members stability	
			new service development investment rates	
		development potential	members study and innovation capacity	
			sales of new service development	

Qualitative research is done by mining issues, observing phenomenon, analyzing human behavior and language. Quantitative research and qualitative research co-exist and analysis issues. They are critical for users finding and solving the problem. By observing we can find out their problems and characteristics [6].

Expert evaluation method, as an early, long-term used evaluation method, which is determined by experts experience, breadth and depth of knowledge and experience, is inherently academic, experiential and professional. On the one hand, it is simple and intuitive. On the other hand, its' not sufficient theoretically and practically, which effects the operational and practical results to some extent.

Brainstorming, a group decision making method, is developing from management theory on a certain level with a series of improved method, which guarantees creativity in group decision-making and improvement of decision-making quality to achieve research through both qualitative and quantitative criteria by scoring. It owns statistics, innovation, faithfulness and instability.

Indicative consideration usually uses the above method [7].

By the method of expert assessment and brainstorming, grading and scoring shall be made according to the actual conditions.

II. Quantitative indicators. Quantitative research is to make hypothesis, collect data, conduct research on indicators according to statistical requirements by surveys and experiments. Normalization approach as one of the quantitative processing methods has optimization, standardization, equalization and other characteristics. In order to facilitate the normalization of data, this paper adopts optimization method, which is to set a maximum value and a minimum value respectively to achieve range requirements.

Benefit indicators functions are as follows:

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$$R \begin{cases} 1, & y_{i} > y^{\max} \\ \frac{y_{i} - y_{i}^{\min}}{y_{i}^{\max} - y_{i}^{\min}} \\ 0, & y_{j} <_{j}^{\min} \end{cases}, & y_{i}^{\max} \ge y_{i} \ge y_{i}^{\min}; \end{cases}$$
(1)

Cost index functions are as follows:

$$R \begin{cases} 1, & y_{i} > y^{\max}; \\ \frac{y_{i}^{\max} - y_{i}}{y_{i}^{\max} - y_{i}^{\min}}, & y_{i}^{\max} \ge y_{i} \ge y_{i}^{\min}; \\ 0, & y_{j} < j^{\min}. \end{cases}$$
(2)

Here y is the actual value, Max is the maximum value, min is the minimum value. III. This paper combines qualitative index with quantitative index for the research of index.

3.2. Modeling

Analytic Network Process (ANP), a decision method combined the hierarchical level, the inner loop, mutual control at the same time with network structure which is suitable for complex structures, was put forward by Set in 1996. Analytic network process is a practical multiple criteria decision making method developing from analytic hierarchy process, which can handle the complex decision-making problems with internal dependencies and external feedback. The main function is to combine all various factors according to its staggered relationship, and to gain the corresponding values with target as a basis by setting value as the other indicator value criteria. Structure of a typical hierarchy analysis is as Figure 1 shows.



Figure 1. Hierarchical Analysis Structure

(1) According to the expert's request, the importance of indicator can be divided into many grades, and you can assume that as grade I, grade II or grade III and so on.

(2) Determine indicator weight, vector and sorting. Major one is to set an indicator as the main criteria, and to compare other indicator to gain the related value by setting value with the main index as the fundamental and other indicators as supplement. Index matrix is as follows:

$$W \begin{cases} W_{W1} & W_{12} & \cdots & W_{1N} \\ W_{21} & W_{22} & \cdots & W_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ W_{NA} & W_{N2} & \cdots & W_{NN} \end{cases}$$
(3)

Here $(W_{ij}l = 1, 2, ..., 5)$; (j = 1, 2, ..., 5))indicates affected extent, that is to gain the feature vector of judgment matrix by making comparative judgment.

Conduct judgment matrix. By making comparative judgment on affected probability to computing the eigenvectors, then the final weight matrix is gained.

Conduct weighted matrix and find the solution. Set the weight value in accordance with effected extend of each index on this column.

Find the solution on the relative ranking vector of weighted super matrix to get the importance of indicators, and use it to resolve the problem.

$$\overline{W} \begin{cases} W_{11}a_{11} & W_{12}a_{12} & \cdots & W_{W1}a_{1N} \\ W_{21}a_{21} & W_{22}a_{22} & \cdots & W_{W1}a_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ W_{W1}a_{NA} & W_{W2}a_{N2} & \cdots & W_{Wn}a_{NN} \end{cases}$$
(5)

4. The Application of Performance Evaluation Model in Logistics Service Supply Chain

The paper make the research on the application of performance evaluation model in logistics service supply chain of the port logistics service provider by taking the example of Jingtang Port in Tangshan, Hebei.

4.1. Determination of the Quantitative Indicators

Based on international services supply chain evaluation system, port logistics standards, laws and regulations, the paper takes into account the port environment A, infrastructure B, capacity C, financial factors D, customer satisfaction standards E as the evaluation criterion according to actual conditions. Here, there are qualitative indicators: port environment and customer satisfaction levels on port services. The establishment of sub index is as Table 2:

		(A ₁) port area conditions
one-level		(A ₂) Port natural conditions
	А	(A_3) Degree of liberalization and international trade port
		(A ₄) Relevant government policy and law environment for the port
		(A ₅) Port management and service organization maturity
		(B ₁) Number of deepwater berths
	D	(B_2) The capacity of handling equipment
	в	(B ₃) Integrated yard area
		(B ₄) Integrated yard machinery storage capacity
((C ₁) cargo handling capacity
two-level		(C_2) Average time in port for each ton cargo ship
		(C ₃) Average residence time and distribution loading port
	C	(C ₄) Highway transportation capacity
		(C ₅) Capacity of Assembling and Distributing Transportation
		(C ₆) Multimodal capabilities
		(D ₁) Return On Equity
		(D_2) Debt Asset ratio
		(D ₃) liquidity ratio
	D	(D ₄) Net asset turnover ratio
	D	(D_5) Average growth rate in main business revenue
		(D_6) Net Profit Grow Rate
three-level		(D_7) Foreign trade import and export amount in absolute terms
		(D ₈) Import and Export volume growth
		(E_1) the Quality of Manager
		(E ₂) Creative Ability
	Е	(E ₃) employee talent
		(E ₄) Corporate Culture
		(E ₅) Customer satisfaction

Table 2. Index System

4.2. Model Solution

Establish indicators matrix, in which W represents above sub index: among these indexes: w11 represents first sub index port environmental conditions of index 1 in the port area; w12 represents second index port the environment conditions of index 1 in the port area; By that analogy, w55 represents fifth sub index service customer satisfaction index of indicator 5 among port customer satisfaction.

According to the qualitative assessment, an analyzed value is obtained:

$$W = (w_1, w_2, w_3, \dots, w_n)$$

(6)

Sets the value for:

<i>w</i> ₁₁	<i>w</i> ₁₂	<i>w</i> ₁₃	<i>w</i> ₁₄	<i>w</i> ₁₅	<i>w</i> ₁₆	<i>w</i> ₁₇
0.0291	0.0283	0.0215	0.0193	0.0147	0.0177	0.0164
<i>w</i> ₂₁	w ₂₂	<i>w</i> ₂₃	w ₂₄	<i>w</i> ₂₅	W ₂₆	w ₂₇

Table 3. Weight Ratio

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0.0107	0.0131	0.0084	0.0078	0.0183	0.0016	0.0091
<i>w</i> ₃₁	<i>W</i> ₃₂	<i>W</i> ₃₃	<i>w</i> ₃₄	<i>W</i> ₃₅	<i>W</i> ₃₆	<i>W</i> ₃₇
0.0072	0.0107	0.0052	0.0035	0.0167	0.0014	0.0053
<i>w</i> ₄₁	w ₄₂	<i>w</i> ₄₃	w ₄₄	<i>W</i> ₄₅	<i>W</i> ₄₆	<i>W</i> ₄₇
0.0439	0.0561	0.0437	0.0348	0.0452	0.0321	0.0432
<i>w</i> ₅₁	<i>w</i> ₅₂	<i>w</i> ₅₃	<i>w</i> ₅₄	<i>w</i> ₅₅	<i>w</i> ₅₆	w ₅₇
0.0625	0.0733	0.0593	0.0495	0.0634	0.0571	0.0699

(2) Establish weight matrix. Based on the facts and expert examination, the paper evaluates the weight of indexes and sub-index, which can be represented by R. $\begin{bmatrix} P \end{bmatrix} \begin{bmatrix} R & R & R \end{bmatrix}$

$$\begin{bmatrix} R_{1} \\ R_{2} \\ \vdots \\ \vdots \\ R_{K} \end{bmatrix} = \begin{bmatrix} R_{11} & R_{12} & \dots & R_{1n} \\ R_{21} & R_{22} & \dots & R_{2n} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ R_{K1} & R_{K2} & \dots & R_{Kn} \end{bmatrix}$$

(3) Set values as:

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$$R = \begin{vmatrix} 1 & 3 & 2 & \frac{1}{2} & \frac{1}{3} \\ \frac{1}{3} & 1 & 2 & \frac{1}{5} & \frac{1}{6} \\ \frac{1}{2} & \frac{1}{2} & 1 & \frac{1}{7} & \frac{1}{8} \\ 2 & 5 & 7 & 1 & \frac{1}{2} \\ 3 & 6 & 8 & 2 & 1 \end{vmatrix}$$

By the calculation, we can get:

(7)

(8)

$$I = WR \begin{cases} 0.018m_1 + 0.084m_2 + 0.207m_3 - 0.332s_1 - 0.358s_2 \ge 0; \\ 0.031m_1 + 0.075m_2 + 0.372m_3 - 0.279s_1 - 0.243s_2 \ge 0; \\ 0.062m_2 + 0.204m_3 - 0.385s_1 - 0.349s_2 \ge 0; \\ 0.062m_1 + 0.119m_2 + 0.252m_3 - 0.323s_1 - 0.244s_2 \ge 0; \\ 0.035m_1 + 0.058m_2 + 0.341m_3 - 0.349s_1 - 0.217s_2 \ge 0; \\ 0.075m_1 + 0.111m_2 + 0.323m_3 - 0.301s_1 - 0.19s_2 \ge 0; \\ 0.066m_1 + 0.124m_2 + 0.359m_3 - 0.27s_1 - 0.181s_2 \ge 0; \\ 0.093m_1 + 0.119m_2 + 0.434m_3 - 0.266s_1 - 0.128s_2 \ge 0; \\ 0.093m_1 + 0.106m_2 + 0.367m_3 - 0.283s_1 - 0.16s_2 \ge 0; \\ 0.058m_1 + 0.075m_2 + 0.35m_3 - 0.279s_1 - 0.238s_2 \ge 0; \\ 0.058m_1 + 0.075m_2 + 0.35m_3 - 0.279s_1 - 0.238s_2 \ge 0; \\ 0.079m_2 + 0.314m_3 - 0.394s_1 - 0.213s_2 \ge 0; \\ 0.018m_1 + 0.081m_2 + 0.257m_3 - 0.313s_1 - 0.331s_2 \ge 0; \\ 0.035m_1 + 0.08m_2 + 0.336m_3 - 0.305s_1 - 0.244s_2 \ge 0; \\ 0.079m_2 + 0.372m_3 - 0.341s_1 - 0.208s_2 \ge 0; \\ 0.062m_1 + 0.097m_2 + 0.324m_3 - 0.279s_1 - 0.27s_2 \ge 0; \\ 0.062m_1 + 0.097m_2 + 0.314m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.009m_1 + 0.084m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.327s_1 - 0.165s_2 \ge 0; \\ 0.018m_1 + 0.088m_2 + 0.372m_3 - 0.$$

Here, m_n refers to the efficiency Index, s_n refers to cost index.

4.3. Results and Analysis

Using Lingo calculation software, we can get: $MaxI_1 = 0.995 \quad MaxI_2 = 0.551 \quad MaxI_3 = 1 \quad MaxI_4 = 0.679 \quad MaxI_7 = 0.853$ $MaxI_8 = 0.494 \quad MaxI_9 = 0.399 \quad MaxI_{10} = 0.3 \quad MaxI_{11} = 0.426 \quad MaxI_{12} = 0.559$ $MaxI_{14} = 1 \quad MaxI_{15} = 0.775 \quad MaxI_{16} = 0.752 \quad MaxI_{17} = 0.586 \quad MaxI_{18} = 0.438$ $MaxI_{19} = 0.647 \quad MaxI_{22} = 0.539 \quad MaxI_{24} = 0.687 \quad MaxI_{28} = 0.57$

Main Indicators	sub-index	Importance
	A_1	0.995
	A_2	0.551
А	A_3	1
	A_4	0.679
	A_5	0
	B_1	0
D	B_2	0.853
D	B ₃	0.494
	\mathbf{B}_4	0.399
	C_1	0.3
	C_2	0.426
C	C_3	0.559
C	C_4	0
	C ₅	1
	C ₆	0.775
	D_1	0.752
	D_2	0.586
	D_3	0.438
D	D_4	0.647
D	D_5	0
	D_6	0
	D_7	0.539
	D_8	0
	E_1	0.687
	E_2	0
E	E_3	0
	E_4	0
	E_5	0.57

 Table 4. The Weight of Each Index Sheet

Note: Among them, the less important factor weighting evaluates to 0

From the above results you can know the liberalization and internationalization of the port and highway transportation capacity are critical for logistics supply chain performance evaluation model. Followed by the condition of the port area, relatively insignificant is cargo throughput and per tons of cargo average time of stay for ship loading and unloading in port. In the logistics supply chain, we shall attach importance to port infrastructure, the port throughput capacity, reduction of investment, transformation of power to other areas.

5. Conclusion

Based on the above study, we can get the following conclusions: the port environment is critical, followed by infrastructure, financial indicators, throughput capacity and customer satisfaction. Among sub index, the port condition is the most important, followed by the handling equipment capacity, multimodal capabilities, ROE. Therefore, under the perspective of logistics services, supply chain performance is closely with port environment most. Therefore, in order to improve performance, we shall pay attention to infrastructure construction and application.

The following measures can be taken:

(1) Improve the program. According to the past as well as relevant knowledge, a capacity-building program shall contain the implementation plan of logistics and supply chain performance.

(2) Provide a platform. Through continuous research, suppliers can get inspiration and learn from peers. With sustainable development of competitors, they shall improve their own constantly. Therefore, build a platform for mutual exchange, which can make suppliers quickly understand sustainable development.

(3) Afford manpower resource. Respect labor standards, establish and maintain a welltrained workforce. Standardize Labor relations management system, get the staff involved in the management, strengthen job stability, and ensure indirect improvement of labor productivity and product quality.

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