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Comparative study of four types of end-to-end logistics service modes based on analytic hierarchy process

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Abstract: *Recently, the Internet of Things (IoT) has expanded rapidly. Consumers expect end-to-end logistics service quality to rise. Thus, end-to-end logistics service quality must be assessed to improve logistical quality and customer satisfaction. Logistics has four main end-to-end service options: conventional distribution, self-established terminal logistics center, convenience store partnership, and self-service cabinet. This paper focuses on four service modalities. We created the indicator layer (A1 transportation link, A2 warehousing link, A3 distribution service link, A4 value-added service link) and scheme layer (B1 co-distribution model, B2 self-established terminal logistics center model, B3 convenience store collaboration model, B4 self-pickup container model) using the analytic hierarchy process (AHP). A judgment matrix is created by analyzing recent market trends and assessing each indicator's importance in modern society. The co-delivery model is the best of the four service modalities. This study examines co-distribution strategy flaws to improve service quality and customer satisfaction. The co-distribution strategy uses digital technology and organizational platforms to improve service quality.*

Keywords: *analytic hierarchy process; end-to-end logistics; logistics service; service quality*

1. Introduction

The digital economy had 974 million online shoppers in December 2024. E-commerce companies launch various goods on online platforms to increase market share [1]. The State Post Bureau reports that express delivery has grown by nearly 30% annually over the past 15 years. Modern B2C e-commerce has helped China's express delivery market grow rapidly. However, homogeneity and price competition will impact logistics. End-to-end logistics optimization is essential for logistical system competitiveness. The logistics industry may improve its future by improving end-to-end logistics. This paper describes the four end-to-end logistics service modalities, their pros and cons, and their characteristics. Hierarchical analysis determines the best mode from four possibilities and the mode with the most customer satisfaction. Perform a detailed study to discover model flaws and suggest ways to improve it.

2. Literature Review

Domestic researchers examine end-to-end logistics service quality, focusing on customer happiness, varied logistics operation modes, logistics transportation modes, and service quality. (1) Client satisfaction. Yang Xiani et al. [2] feel that end-to-end logistics' reliability, professionalism, and responsiveness increase customer trust and happiness, but empathy does not. Lv Guoqing [3] found that e-commerce terminal logistics service quality affects consumers' repurchase intention and that customer perceived value partially mediates this relationship. Qin Xuan [4] found that customer trust and perceived risk can affect end-to-end logistics service quality and consumer happiness. (2) Multiple logistics models. Li Hui and Li Hangmin [5] say that in end-to-end logistics service management, customers' demands should be prioritized to segment the market by demand, distinguish services, and rationalize customer service. Winston Wu et al. [6] suggested improving end-of-line delivery services by improving logistics and distribution infrastructure, economies of scale, logistics informationization, and courier skills. According to Filina Dawidowicz Ludmiła et al. [7], transshipment logistics primarily occur near terminals. Customer demand impacts transshipment terminal operations and evolves integrated logistics services. (3) Logistics and transport. Yang Yupeng [8] chose areas near the province capital and similar to third-party logistics distribution and self-run logistics distribution survey points to

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decrease geographically related research errors. Li Ji [9] proposed a disturbance management model for simultaneous pickup and delivery of fresh products under time window change, which can improve the end-to-end logistics system's ability to cope with disturbance events and provide decision support for logistics planning. Li Wei, Yang Yanmei et al. [10] created a soft time window urban end-to-end logistics distribution model to optimize the distribution path and reduce logistics transportation costs by considering traffic congestion costs from a quality of service perspective. (4) Quality service. Ruirui Chor [11] investigated the satisfaction of private express delivery firms' end logistics service quality and discovered that last-link logistics problems had a big impact. Peng Runhua and Lin Xiaoxiao [12] suggest helping customers prepare, strengthening service awareness, promoting effective communication, implementing relationship marketing, and controlling direct contact to reduce negative impact to improve customer service quality. Numerous foreign experts have produced theories and ways to improve end-to-end logistics. More complex marine logistics model formulation and loading mode.

Consumer happiness and novel logistics service models are being studied by domestic and foreign researchers to solve current problems. Insufficient study has uncovered and addressed end-to-end logistics service quality issues. This study analyzes four end-to-end logistics services, identifying issues and suggesting quality improvements.

3. Research Design

3.1 Research methodology

Analytic hierarchy uses qualitative and quantitative multi-criteria decision analysis. This method integrates qualitative and quantitative analysis using a hierarchical model, judgment matrix, weight vector, consistency testing, and others. At each component level, pairwise comparisons determine factor importance. It aids scientific decision-making. End-to-end logistics supply chain management and operational optimization need complex logistics distribution center selection, service quality, and cost control. Hierarchical analysis allows logistics service model evaluation by simplifying difficult quantitative problems.

3.2 Logistics service evaluation system construction

3.2.1 Program layer selection

Domestic e-commerce and rapid delivery companies are studying distribution methods and the importance of distribution endpoints and their constraints. The ultimate delivery mode is either direct (door-to-door) or indirect (self-service pickup). Four versions of the two main distribution models focus on different service features. The logistics distribution model's service-oriented components focus on the distribution entity, commodity category, service recipient, and technical application.

(1) Distribution of the main body as a key service object

E-commerce platforms (Jingdong, Suning E-shopping), community group-buying platforms (Meituan Preferred, DuoDuo Buying), and express delivery corporations make up the core distribution framework. Home delivery, pickup points, and smart express lockers are common. Community organization delivers orders via courier or takeaway to supermarkets or community centers where purchasers can pick them up.

(2) Distribution of goods type as a priority service object

Logistics service models are categorized by commodity distribution. The type of goods delivered determines the logistics distribution technique and location. Merchants will choose distribution logistics for precious commodities, including home appliances, jewels, and electronics. Distribution is usually done to the customer's doorstep and requires special safety procedures. Providing excellent customer service to satisfy customers.

(3) Service recipients are priority service recipients

It is often categorized into B2B clients and B2C customers. The B-end mostly caters to enterprises and retailers. The majority of firms and merchants will possess their own terminal logistics facility. Their objective is to deliver goods to purchasers and clients. C-end clients are for personal use and prioritize the promptness and precision of delivery. The service model tailored for these users is varied

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and individualized. Diverse, tailored offerings are favored by their respective audience segments.

(4) Degree of technology application as a priority service target

Variations in technical application are key to the service model. Traditional distribution scheduling and allocation need manual inspection and control of distribution instruments. Traditional distribution model users are declining due to inefficiency and delayed information feedback. Modern distribution tactics use big data, AI, the IoT, and other technologies to optimize scheduling and routes. Increases distribution efficiency and precision.

3.2.2 Analysis of end-to-end logistics model

These two major service modes can be classified. Distribution entities, product categories, distribution items, and technological resources address the four service mode concerns. The normal distribution model is rookie station, then self-established terminal logistics center, convenience store collaboration, and pick-up cabinet.

(1) Common Distribution Model

The co-distribution strategy emerged from "coordinated distribution," which shared logistics resources among multiple enterprises to achieve economies of scale and environmental aims. [12] Collective efforts with third-party logistics providers will increase resources and benefits, lower costs, and boost efficiency for firms. Co-distribution has grown beyond consolidated transportation in scope and complexity. Many companies are expanding into new markets, product categories, or activities as the economy grows. Logistics and distribution development is moving toward co-distribution, unlike the other four models. This paradigm has practical obstacles and impediments, and implementation will likely present challenges. Several firms have shortcomings in their business districts, particularly in client involvement, business acumen, and other areas that inhibit harmonization.

(2) Self-established terminal logistics center model

Self-established terminal logistics centers are created and managed by businesses. For its business needs and growth strategy, the company builds a custom logistics center including warehousing, sorting, distribution, and other operations. Having its own terminal logistics center lets the company manage the logistics process and adjust to market developments and consumer needs. Quality, communication costs, and outsourced security improve with self-established terminal logistics solutions. The self-built terminal logistics center is expensive to create and operate. The public should not employ this technique, but large companies with strong logistics service quality standards should.

(3) Cooperation model with convenience stores

Convenience stores may accept couriers or self-pickup. Couriers and convenience stores collaborate to use them as logistical endpoints.[14] This method reduces receiver absenteeism and boosts delivery efficiency. Customers return to the convenience store after purchase, increasing revenue and attraction. Both parties benefit from mutual reinforcement. Convenience stores' vast distribution helps companies market their products.

(4) Pick-up counter model

Many homes, businesses, schools, and other densely populated places employ self-pickup lockers. If the recipient is absent during courier delivery and the box is placed in a self-pickup cabinet, the system will SMS the pickup code and other details. A pickup code lets the recipient retrieve the delivery from the pickup cabinet. [15] Reduces courier signature time, distribution time, and car lane blocking. Self-service cabinets have system failures, retrieval challenges, and limited capacity for large merchandise. [16]

Analysis reveals that the four aforementioned distribution service modalities of end-to-end logistics possess distinct advantages and disadvantages. This research employs hierarchical analysis to identify the service model that yields the best customer happiness.

3.3 Selection of indicators

Logistics includes shipping, warehousing, distribution design, and value-added services. Logistics transportation involves selecting the appropriate mode (road, rail, air, or river) depending on commodity qualities, distance, and cost and developing optimal routes for cost-effective, efficient, and timely delivery. Warehouses store, sort, and retrieve goods securely. Distribution services sort, package,

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and distribute items to streamline logistics after receiving, analyzing, and processing customer orders. Customer satisfaction is improved via real-time logistics tracking (via big data/IT) and customized solutions like payment collection or packaging, with hierarchical analysis detecting operational consequences.

Customer satisfaction is enhanced via money collection and packaging adjustment. To accurately measure logistics services and determine which component most impacts operations. Hierarchical analysis clarifies logistics service evaluation outcomes.

3.4 Solution results

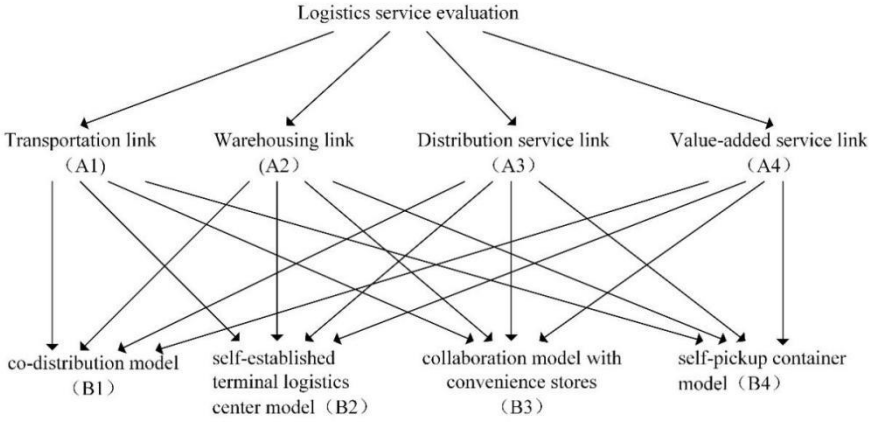

Figure 1 Modeling the hierarchy

As shown in Figure 1 the transportation link is marked A1, the warehousing link is marked A2, the distribution service link is marked A3, and the value-added service link is marked A4. The four modes of end-to-end logistics service to be evaluated are also marked on the indicators. B4 is the self-pickup container model.

The provisions for comparing quantified values between indicators are shown in Table 1: two-by-two comparisons between two elements, with levels of equal importance assigned to 1, more important to 3, very important to 5, and extremely important to 7. Also, intermediate values are set for two neighboring judgments: 2, 4, 6, and 8.

Table 1 Quantitative values of elements

dividing factor	sample value (math.)
equal importance	1
more important	3
very important	5
vital	7
The median of two neighboring judgments	2, 4, 6, 8
from the bottom (lines on a page)	$a_{ij} = 1/a_{ji}$

The judgment matrix of the evaluation index layer of the terminal logistics service is established, the four elements are compared with each other, and different weights are given according to the importance of the comparison index.

Table 2 Creating a judgment matrix

norm	A1	A2	A3	A4
A1	1	1/6	1/3	1/5
A2	6	1	5	3
A3	3	1/5	1	1/3
A4	5	1/3	3	1
$\sum$	15	1.7	9.33	4.53

Normalize Table 2. Add the numbers in each vertical column to get the SUM, then find the ratio of each number in the table to it. Three decimal places are used. Table 3 shows the priority of each row based on its average value.

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Table 3 Normalization

norm	A1	A2	A3	A4	prioritization
A1	0.067	0.098	0.036	0.044	0.061
A2	0.400	0.588	0.536	0.662	0.547
A3	0.200	0.118	0.107	0.074	0.125
A4	0.333	0.196	0.322	0.221	0.268

The consistency test of calculation results is shown in Table 4:

Table 4 Consistency test

norm	A1	A2	A3	A4	line summation
A1	0.061	0.091	0.042	0.054	0.248
A2	0.366	0.547	0.625	0.804	2.342
A3	0.183	0.109	0.125	0.809	0.509
A4	0.305	0.182	0.375	0.264	1.130

The results of the calculated maximum eigenvalues are presented in Table 5:

Consistency indicators CI : $\mathrm{C}I = \frac{\lambda_{\max} - n}{n-1}$ (n is the number of comparison terms)

Consistency ratio $\mathrm{C}R$: $\mathrm{CR} = \frac{CI}{RI}$ (RI is a randomly generated consistency ratio for a two-by-two comparison matrix, the size of which depends on this comparison term)

Table 5 Maximum eigenvalue calculation results

norm	Maximum eigenvalue
A1	4.066
A2	4.282
A3	4.072
A4	4.216

$\lambda_{\max}$ =4.159

$\mathrm{C}L$ = 0.053

CR <0.10 Consistency

Use Table 6 to calculate the portfolio weight vector and conduct an overall ranking:

Calculate program priorities:

B1:0.558×0.061+0.792×0.547+0.399×0.125+0.610×0.268

B2:0.186×0.061+0.264×0.547+0.285× 0.125+0.366×0.268

B3:0.080×0.061+0.053×0.547+0.057× 0.125+0.041×0.268

B4:0.112×0.061+0.088×0.547+0.171× 0.125+0.122×0.268

Table 6 Calculation of the portfolio weight vector as well as the overall ranking

	A1 (0.061)	A2 (0.547)	A3 (0.125)	A4 (0.268)		Comprehensive Ranking
B1	0.558	0.792	0.399	0.610	0.681	1
B2	0.186	0.264	0.285	0.366	0.289	2
B3	0.808	0.053	0.057	0.041	0.052	4
B4	0.112	0.088	0.171	0.122	0.110	3

B1>B2>B4>B3

In conclusion, clients choose a common distribution for end-to-end logistics service evaluation. However, the traditional distribution approach has disadvantages such as (1) the usual distribution model objectively has interests, duties, and risks. A comparable distribution strategy may not share gains fairly for national logistics service companies. Transportation concerns might confound

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corporation risks and duties. (2) Government departments vary in urban co-allocation protection and cognition. The current analysis suggests that counterpart departments struggle to engage with the Ministry of Commerce, slowing urban co-allocation. This hinders conventional distribution model development.

4. Optimization strategy of end-to-end logistics service mode

4.1 Use of digital drive technology

4.1.1 Data-driven realization of path optimization

Traffic data and clever algorithms can alter the distribution path based on road conditions to maximize speed, efficiency, and cost. Smart distribution algorithms and traffic data estimate peak traffic times and find traffic-free regions. [13] It lowers operating costs and helps organizations compete in a competitive market.

4.1.2 Intelligent warehousing and automated picking

Intelligent warehousing solutions improve end-of-line logistics management, automatically classify commodities, and ensure storage rationality and safety. [17]

4.1.3 Promoting green distribution

To improve customer satisfaction and core competitiveness, businesses must identify and optimize high-energy-consuming distribution modes, eliminate high-energy-consuming distribution equipment, and implement as many energy-saving and environmentally friendly distribution modes as possible. [18]

4.2 Optimizing the organizational platform

Many organizations and firms collaborate and support the common distribution model, and maximizing its structure and administration is essential for improving end-to-end logistical services. Organization and management must improve to implement the shared distribution model in digitalization.

4.2.1 Transparency of data information

Companies can collaborate with other organizations and publish data and information using information systems within the standard distribution paradigm, enhancing openness. Logistics are complicated by interdepartmental transmission of vital data. Logistics data and department roles will be visible, decreasing workload and clarifying job allocation.

4.2.2 Flattening of the organizational structure

Businesses can switch from the vertical integration mode to the horizontal integration mode to create a more efficient and effective organizational structure by reducing the burdensome hierarchical mode, management errors, and expenses.

5. Summary and Outlook

This article discusses the four basic business end-to-end logistics services. Each mode's transportation, warehousing, distribution, and value-added services are assessed. Hierarchical analysis determines the co-distribution mode with the highest score, finest service, and most customer contentment from these four parameters. This paper describes optimization methods to increase standard distribution model service quality and customer happiness. Analyzing model difficulties and evaluating relevant literature, it offers data-driven techniques, environmental sustainability, information integration, organizational flattening, and logistics parks to improve end-of-line logistics services.

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