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Artificial intelligence usage, incentives measurements, and operational mechanisms for smart logistics: Basis for improved customer service framework

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Abstract

With the rapid development of the global economy, the logistics industry has maintained a good momentum of sustained and rapid development, and the industry scale and service capability have been significantly improved. Logistics has become an important pillar industry for the development of the national economy. However, some long-standing factors seriously restrict the rapid development of logistics industry, logistics costs remain high, market competition is not standardized, weak profitability of enterprises and low profit margins and other problems affect the sustainable development of logistics industry. Therefore, with the continuous progress of science and technology, logistics service providers need to use new technologies and innovative methods to improve logistics efficiency, reduce costs, and meet the service needs of consumers. The application of artificial intelligence in the logistics industry provides important technical support for the intelligent logistics operation mode, and intelligent logistics can realize the system perception of logistics transportation, warehousing, packaging, loading and unloading, circulation processing, distribution and other links. Comprehensive analysis, timely processing and self-adjustment functions to achieve logistics regularity intelligence, discovery intelligence, innovation intelligence and system intelligence. It is obvious that the application of artificial intelligence in the logistics industry and the smart logistics operation model are becoming a new choice for logistics service providers. The smart logistics operation mode is the only way for the development and transformation of the logistics industry. The smart logistics marked by modern information technology is entering a stage of rapid development. This paper takes logistics service providers, especially those in China, as the research object, and analyzes the AI tools and incentives they choose in adopting intelligent logistics operation models. Specifically, the paper analyzes the incentive factors for logistics service providers to choose smart logistics from the relevant policies of enterprises, logistics industry and government departments, that is, studies which policies and measures promote the adoption of smart logistics operation mode by logistics service providers. This paper studies the influence factors of the choice of intelligent logistics mode on the service efficiency, service accuracy and service reliability of

logistics service providers. Finally, select transportation, warehousing and distribution three important links, to study how the smart logistics operation mode affects the operation of each link of logistics. This paper mainly uses questionnaires to collect and organize data, among which the survey objects are distributed in Beijing, Tianjin and Hebei Province in China. To be specific, typical logistics service providers in three regions are selected as research objects, and questionnaires are conducted for employees at different levels to study the application of smart logistics by logistics service providers from different perspectives, and finally an improved logistics service framework is obtained.

Keywords: smart logistics, artificial intelligence usage, incentives measurements, service framework

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1. Introduction

As an important component of the national economy, the logistics industry has become an important link connecting production and consumption. At the same time, the logistics industry involves multiple regions such as urban, rural, domestic, and international. The complexity, diversity, and imbalance of logistics demand bring many challenges to the management, organization, and operation of logistics, leading to varying degrees of increase in logistics costs. At the same time, logistics efficiency and quality may be negatively affected, ultimately resulting in a high proportion of logistics costs to GDP.

Taking China as an example, as the world's largest producer and one of the world's largest consumers, China has a huge demand for logistics. In 2020, China's total social logistics volume ranks first in the world, with a value of 300.1 trillion, accounting for 25% of the global total. By 2023, China's total social logistics will increase by 5.23 billion yuan on the basis of 2020. However, the proportion of logistics costs to GDP in Western countries is only about 7%, while in China, this figure is as high as 15%. Faced with such a gap, smart logistics has become a good choice. Intelligent logistics is based on information technology and integrates modern management methods (Chen et al., 2021). Unlike traditional logistics, which passively perceives logistics information, smart logistics uses intelligent methods to collect and process logistics information in various links, such as procurement, transportation, packaging, and information services, achieving the goal of comprehensive analysis, processing, and adjustment. In order to further improve the operational efficiency of the logistics industry, enhance customer service levels, and reduce logistics costs, the application of AI and smart logistics operation models has become the primary choice for many logistics service providers (Chen et. al.,2019).

However, China's smart logistics started relatively late, with inadequate management mechanisms, inadequate logistics infrastructure, serious waste of logistics resources, decreased profits for logistics service providers, a lack of professional logistics management talents, and low level of logistics informatization, which to some extent have constrained the further development of China's smart logistics. For example, in terms of smart logistics management mechanisms, smart logistics involves many industries such as commerce, transportation, and information technology. The management departments of logistics business include the Ministry of Transport, the Ministry of Industry and Information Technology and other administrative departments. Based on the above factors, the development of smart logistics requires support and cooperation across industries and management departments, which to some extent increases the difficulty of smart logistics construction and development and requires collaboration from multiple sectors of society (Cheng, 2019). When it comes to logistics infrastructure, there are complex internal and external factors.

From the perspective of external factors, the main reason is that China has a vast territory, complex terrain, and significant disparities in economic development among different regions, resulting in outdated infrastructure in some areas, especially the huge gap in logistics services between rural areas and cities. From an internal perspective, China has a large number of logistics service providers, but there are not many logistics service providers with the ability to achieve comprehensive and multi-dimensional popularization of intelligent logistics. Most small logistics service providers as well as medium-sized logistics service providers still adopt the traditional operation mode of relying mainly on manpower. Meanwhile, another major factor hindering logistics service providers from adopting smart logistics operation models is the serious waste of logistics resources. Based on China's national conditions, logistics industry’s development is facing problems such as wide transportation range, scattered logistics resources, low level of intelligence, and high empty load rate of some routes, which leads to serious waste of logistics resources and greatly increases social logistics costs. More seriously, factors such as uneven distribution of logistics resources, low ability to organize goods, and simple

management methods have increased the operational burden on logistics service providers. Therefore, the integrated use of the Internet, the Internet of Things and AI technology to integrate idle logistics resources and promote the integration of idle resources is a necessary link in smart logistics' construction.

The decline in logistics profits is also an important factor hindering logistics service providers from adopting artificial intelligence and smart logistics operation models. Due to fierce competition in the industry, as well as the increase in talent training, equipment deployment, labor costs, and third-party logistics cooperation costs, the profits of the logistics industry have been severely squeezed, and some small logistics service providers and medium-sized logistics service providers are even hovering on the edge of the breakeven point. If a company does not have sufficient funds for equipment upgrades and operating costs remain high, it will create a vicious cycle. In addition to the aforementioned hard power factors, soft power is also very important. Logistics management professionals are the soft power to establish a smart logistics operation system and one of the decisive factors related to the success or failure of logistics service providers in transitioning to smart logistics. At present, the scale of logistics management, logistics engineering, logistics and supply chain management, procurement management and other logistics professionals trained by advanced universities in China is increasing year by year (Fang 2020). However, the talent training methods are disconnected from the logistics industry's rapid development, and management knowledge and models are not updated in a timely and effective manner. The concept of logistics globalization is weak, resulting in long employment training cycles and high costs for employees (Huang 2020). In terms of logistics information, there is currently no systematic information resource sharing and industrial network platform in the logistics industry.

On the one hand, it is difficult to connect manufacturers, retailers, and customers smoothly, making it difficult to optimize the industrial chain and close cooperation. At the same time, it also makes the development of third-party logistics unbalanced and incomplete. On the other hand, it causes waste of logistics resources, increases logistics costs, low optimization space, and decreased competitiveness. Therefore, for China, improving logistics infrastructure and allocating logistics resources reasonably are the foundation for achieving the development of the logistics industry. Logistics service providers who want to realize intelligent logistics operation also need to pay attention to the application of information technology in logistics management and logistics system planning, and actively promote the application of information technology in logistics process technology and control, logistics operation and other aspects, in order to obtain broader survival and development space. We should pay attention to the efforts and cooperation of logistics service providers, equipment providers, and social capital to help enterprises transform and upgrade towards intelligent logistics development. From a talent perspective, we can vigorously promote the talent cultivation method of "school enterprise cooperation", achieve linear talent transmission and training, and shorten the talent training cycle. In addition, the obstacles to the development of intelligent logistics in China are also reflected in the inadequate logistics information standard system. Standardization of logistics information is an important foundation for achieving smart logistics. As information standardization can meet the standardization of logistics information in coding, data interfaces, electronic data exchange (EDI), and global positioning system (GPS) codes, it can eliminate information communication barriers caused by different logistics information standards for different enterprises. In developed countries, due to their long operation time in the logistics industry, a set of standards has been established in both barcode and information exchange structure, which can better facilitate communication and provide services between enterprises and customers, suppliers, etc.

However, China still lacks basic information standards, which hinders the informatization development of logistics and leads to incomplete construction of logistics standardization system. The informatization business standards and technical standards of logistics are difficult to match the development needs of logistics informatization, thus making it difficult for enterprises to achieve smooth information exchange and sharing with platforms and organizations. The logistics information network is difficult to be compatible, there are obstacles to data exchange, and information sharing is not smooth, making it difficult to form a complete and smooth supply chain from production to circulation, to consumption and other links of goods, which affects the intelligent management of the logistics industry. At present, many logistics service providers in China have

begun to use Internet of Things technology to build smart logistics systems. However, these enterprises are generally small in scale, unevenly distributed nationwide, and lack effective management measures, resulting in chaotic management and difficulty in forming a unified, open, and orderly market. Most small and medium-sized service providers find it difficult to achieve logistics informatization. Due to a lack of corresponding talents and funds, the management does not attach enough importance to information technology. Even if relevant smart logistics technologies are introduced, the supporting infrastructure cannot keep up, resulting in no significant improvement in enterprise efficiency. Overall, many factors have led to a low level of intelligence among Chinese logistics service providers. However, for logistics service providers and the logistics industry, the application of artificial intelligence tools and smart logistics models provides good development opportunities. It can be said that the intelligent development of logistics service providers is not only a technical issue, but also a management issue. A series of scientific questions need to be answered, such as what are the reasons that hinder logistics service providers from adopting artificial intelligence technology, what are the incentive factors that affect logistics service providers to adopt smart logistics operation mechanisms, how do these factors affect the development and degree of influence of smart logistics, and what is the smart operation mechanism of logistics service providers.

This study focuses on logistics service providers, aiming to investigate their use of artificial intelligence tools, explore the multi perspective incentive factors for adopting smart logistics models, and study the smart logistics operation mechanism of logistics service providers. Through smart logistics, build a bridge between the logistics industry and modern information technology, and jointly build an efficient logistics service system. For logistics service providers, research on incentive factors and intelligent operation mechanisms provides good development opportunities for enterprises. If the development of logistics service providers can adapt to artificial intelligence technology and intelligent logistics operation mechanisms, it can effectively reduce the comprehensive cost of enterprise logistics, improve the profitability of enterprises, improve customer service levels, and greatly enhance the competitiveness of logistics service providers. This study can provide practical and feasible suggestions for the Chinese government and logistics management departments, assist relevant management departments in better formulating policies and regulations for the intelligent development of the logistics industry, and continuously play the leading and regulatory role of industry management departments.

Objectives of the Study - This study aimed to determine the usage of artificial intelligence tools by logistics service providers, adopt multi angle, multi incentive factors and operating mechanisms of intelligent logistics operation models, and how to formulate framework to improve the customer service. Specifically, this study aimed to determine the artificial intelligence usage of logistics service providers in terms of service efficiency, accuracy, and reliability; describe the incentive measures for Chinese logistics service providers to adopt the smart logistics model in terms of internal incentive policy, government policy and industry policy; describe the operational mechanisms of logistic service providers in terms of transportation, storage and distribution; test the significant relationship among artificial intelligence usage, incentives and operational mechanisms; develop a framework to improve the customer services.

2. Methods

Research Design - This study evaluates the service efficiency, service accuracy and service reliability of logistics service providers under the smart logistics mode by using a questionnaire method, and studies the internal incentive factors, industry incentive factors and government incentive factors that affect logistics service providers to adopt the smart logistics operation mechanism. It also analyzes the behavior and measures of logistics service providers from the perspective of intelligent transportation, intelligent warehousing and intelligent distribution, and provides effective guidance for enterprises and governments to formulate policies. In the first part of the study, through the analysis of the questionnaire results, the important factors affecting the adoption of intelligent logistics operation mode by Chinese logistics service providers are summarized. The second part is qualitative analysis, that is, according to the research results, researchers explore the influencing factors of Chinese logistics service providers' choice of smart logistics mode. Finally, it summarizes the policy

opinions and suggestions applicable to logistics service providers and the government.

Research Participants - In this study, logistics service providers in Hebei Province, Beijing City and Tianjin City were selected as questionnaire survey objects. After layers of screening, 15 service providers meeting the characteristics of smart logistics operation were selected as questionnaire survey objects. Specifically, considering that employees at different levels can consider the factors affecting the operation of intelligent logistics and the operation mechanism of intelligent logistics at different levels, questionnaires are issued respectively for management, middle management and grass-roots staff. The specific staff ratio is 30 managers, 60 middle managers and 300 enterprise employees. The questionnaire was distributed by a combination of personal distribution and E-mail.

Data Gathering Instrument - The main tool of this study is questionnaire. The questionnaire consists of 3 parts and 9 questionnaires. The first part of the questionnaire collects the status of logistics service providers in the target regions of China who choose the smart logistics operation mode, specifically the impact of the smart logistics mode on service efficiency, service accuracy and service reliability. The second part studies the incentive factors that influence logistics service providers to choose smart logistics mode, and collects data from internal incentive factors, industry incentive factors and government incentive factors respectively. The third part involves the specific logistics business field, select the representative transportation, warehousing and distribution three links, analyze and collect the application and development of intelligent transportation, intelligent warehousing and intelligent distribution.

Data Gathering Procedure - Before the formal distribution of questionnaires to collect data, first of all, logistics engineering graduates of North China University of Science and Technology working in logistics enterprises in Hebei Province to conduct a small range of pre-survey, the main purpose is to obtain feedback information from logistics service providers for the questionnaire, in order to timely optimize the questionnaire topic description, sequence setting, wording and so on. At the same time, exploratory factor analysis and reliability test were carried out to ensure the reliability and validity of the final questionnaire. According to the problems found in the process of pre-investigation and the results of reliability and validity analysis, the questionnaire was adjusted in time. In the process of formal questionnaire distribution, the form of personal distribution and email distribution.

Ethical Considerations - The researchers also took ethical considerations into account when conducting the study. All the questionnaire participants are voluntary and anonymous, and the researchers promise that the information of the participants will be strictly confidential, and no names or personal identification information will be involved in the questionnaire, so as to dispel the concerns of the respondents when filling out the questionnaire.

Data Analysis - Weighted mean and rank were used to determine the artificial intelligence usage of logistics service providers in terms of service efficiency, accuracy, and reliability; to describe the incentive measures for Chinese logistics service providers to adopt the smart logistics model in terms of internal incentive policy, government policy and industry policy; and to describe the operational mechanisms of logistic service providers in terms of transportation, storage and distribution. The results of the Shapiro Wilk test indicate that the p-values of all variables are below 0.05, indicating a positive distribution in the dataset. Therefore, as part of the non parametric test, Spearman rho was used to determine significant relationships.

3. Results and discussion

The second part, which discusses the incentives for logistics service providers to use AI tools and smart logistics operating models, is presented in Table 1. The weighted average is 3.16, which is a very good result. Among them, the intelligent logistics model of logistics service providers can realize real-time adjustment of inventory levels and reduce the company's inventory cost score of 3.21, which is the highest score. Secondly, the intelligent logistics mode of logistics service providers can achieve efficient receipt of goods and improve the

efficiency of goods supply, with a score of 3.18. The lowest score for the logistics service provider's smart logistics model has significantly improved the company's level, scoring 3.12.

Table 1

Summary Table on Artificial Intelligence Usage of Logistics Service Providers

Key Result Areas	Composite Mean	VI	Rank
Service Efficiency	3.16	Agree	2.5
Service Accuracy	3.16	Agree	2.5
Service Reliability	3.19	Agree	1
Grand Composite Mean	3.17	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 2

Summary Table on Incentive Measures for Chinese Logistics Service Providers to Adopt the Smart Logistics Model

Key Result Areas	Composite Mean	VI	Rank
Internal Incentive Policy	3.16	Agree	2
Government Policy	3.15	Agree	3
Industry Policy	3.18	Agree	1
Grand Composite Mean	3.16	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 2 lists the application of artificial intelligence of logistics service providers and the influence of internal incentive factors, industry incentive factors and government incentive factors in the selection of intelligent logistics operation mode, and the comprehensive average value is 3.16. Among them, the impact of industry incentives received the highest score of 3.18, which was interpreted as very good.

Table 3

Summary Table on Operational Mechanisms of Logistic Service Providers

Key Result Areas	Composite Mean	VI	Rank
Smart Transportation	3.15	Agree	3
Smart Storage	3.19	Agree	2
Smart Distribution	3.21	Agree	1
Grand Composite Mean	3.18	Agree	

Legend:3.50-4.00=Strongly Agree;2.50-3.49=Agree;1.50-2.49=Disagree;1.00-1.49=Strongly Disagree

Table 3 lists several important measures for logistics service providers to apply smart logistics mode, including smart transportation, smart warehousing and smart distribution, with a combined average value of 3.18. Among them, the comprehensive average of smart delivery is the highest, which is 3.21, and the performance is very good.

Table 4

Relationship Between Artificial Intelligence Usage and Incentive Measures

Variables	rho	p-value	Interpretation
Service Efficiency			
Internal Incentive Policy	0.487**	< .001	Highly Significant
Government Policy	0.529**	< .001	Highly Significant
Industry Policy	0.494**	< .001	Highly Significant
Service Accuracy			
Internal Incentive Policy	0.542**	< .001	Highly Significant
Government Policy	0.529**	< .001	Highly Significant
Industry Policy	0.556**	< .001	Highly Significant
Service Reliability			
Internal Incentive Policy	0.515**	< .001	Highly Significant
Government Policy	0.540**	< .001	Highly Significant
Industry Policy	0.475**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

As seen in table 4, the computed rho-values ranging from 0.475 to 0.556 indicate a moderate direct relationship between artificial intelligence usage and incentive measures. There is a statistically significant relationship between artificial intelligence usage and incentive measures because the obtained p-values were less than 0.01. As seen in table 5, the computed rho-values ranging from 0.447 to 0.546 indicate a moderate direct relationship between artificial intelligence usage and operational mechanisms. There is a statistically significant relationship between artificial intelligence usage and operational mechanisms because the obtained p-values were less than 0.01.

Table 5

Relationship Between Artificial Intelligence Usage and Operational Mechanisms

Variables	rho	p-value	Interpretation
Service Efficiency			
Smart Transportation	0.520**	< .001	Highly Significant
Smart Storage	0.546**	< .001	Highly Significant
Smart Distribution	0.513**	< .001	Highly Significant
Service Accuracy			
Smart Transportation	0.546**	< .001	Highly Significant
Smart Storage	0.527**	< .001	Highly Significant
Smart Distribution	0.513**	< .001	Highly Significant
Service Reliability			
Smart Transportation	0.447**	< .001	Highly Significant
Smart Storage	0.448**	< .001	Highly Significant
Smart Distribution	0.457**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

As seen in table 6, the computed rho-values ranging from 0.393 to 0.595 indicate a weak to moderate direct relationship between incentive measures and operational mechanisms. There is a statistically significant relationship between incentive measures and operational mechanisms because the p-values were less than 0.01.

Table 6

Relationship Between Incentive Measures and Operational Mechanisms

Variables	rho	p-value	Interpretation
Internal Incentive Policy			
Smart Transportation	0.444**	< .001	Highly Significant
Smart Storage	0.439**	< .001	Highly Significant
Smart Distribution	0.393**	< .001	Highly Significant
Government Policy			
Smart Transportation	0.595**	< .001	Highly Significant
Smart Storage	0.527**	< .001	Highly Significant
Smart Distribution	0.485**	< .001	Highly Significant
Industry Policy			
Smart Transportation	0.563**	< .001	Highly Significant
Smart Storage	0.553**	< .001	Highly Significant
Smart Distribution	0.501**	< .001	Highly Significant

***. Correlation is significant at the 0.01 level*

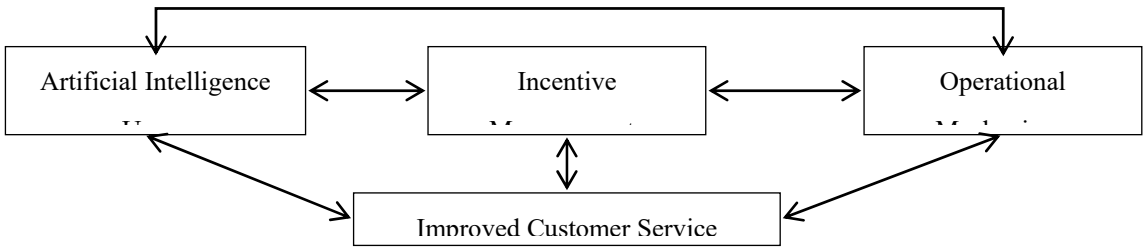

Figure 1. Improved Customer Service Framework for Smart Logistics Service Providers

The diagram outlines a framework for improved customer service within the smart logistics industry. It

highlights three key areas that contribute to customer service excellence like Artificial Intelligence Usage, Incentives Measurements, and Operational Mechanisms. Customer Service Excellence in the Digital Age Connecting the Framework to Customer Service Excellence, this may help in Artificial Intelligence Usage like AI-powered chatbots and virtual assistants can provide 24/7 support, addressing inquiries promptly (Verhoef et al., 2019). AI-based sentiment analysis of social media interactions can help identify customer concerns, promoting proactivity (Ahn et al., 2018).

Under Incentives Measurements, it includes understanding customer preferences through data analysis can enable personalization of service offerings and loyalty programs (Kumar et al., 2017). By measuring customer satisfaction with incentives, companies can identify areas for improvement in their service (Seaman et al., 2019). On its Operational Mechanisms, it can Streamlined logistics operations through route optimization software ensure faster deliveries, enhancing responsiveness (Toth et al., 2014). Real-time shipment tracking through operational mechanisms empowers companies to proactively notify customers about their orders (Christopher et al.,2011). Overall, the framework emphasizes leveraging digital technologies (AI) and data analysis to create a customer-centric approach to service excellence.

4. Conclusion and recommendation

The employee interviewees unanimously believe that using artificial intelligence tools and intelligent logistics operation mechanisms as logistics service providers can improve decision-making, operational efficiency, and level, and bring significant competitive advantages to logistics service providers in terms of internal and external incentive factors and influencing measures. The respondents unanimously believe that artificial intelligence plays a crucial role in improving service efficiency and accuracy, especially in service reliability. The incentive factors for adopting intelligent logistics include internal factors of the enterprise, industry factors, and government incentive factors. There is a significant relationship between the application of artificial intelligence tools and the influence of incentive factors, which can enhance the competitiveness and adaptability of logistics service providers in increasingly complex business environments. An Improved Customer Service Framework for Smart logistics was developed.

For logistics service providers, they may invest more money in artificial intelligence technology, including data mining tools, applied computer vision recognition tools to have more efficient services. Logistics service providers may strengthen the intelligent operation of all aspects of logistics including intelligent transportation, warehousing distribution, in addition to packaging, loading and unloading, circulation processing, logistics information flow and other logistics operations throughout the process. For the logistics industry, it may accelerate the standardization of smart logistics and build a coordinated and unified standard system under the guidance of industry associations and other organizations. The improved customer service framework can be reviewed and adopted by the logistics companies. The future researchers are encouraged to strengthen the research on the application of intelligent logistics technology, independent innovation capabilities in logistics services emphasizing the talent cultivation of smart logistics to improve the efficiency, accuracy, and service reliability.

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