

Application and Philosophical Reflection of Dialectics of Nature in Modern Logistics Engineering and Management

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Abstract

Original Research Article

As a typical interdisciplinary discipline integrating engineering technology and economic management, logistics engineering and management faces multiple contradictions and practical dilemmas in the context of digitalization and green low-carbon transformation, such as the opposition between operational efficiency and ecological sustainability, the conflict between technological instrumental rationality and humanistic value rationality, and the imbalance between localized development and globalized layout. The Dialectics of Nature, as the core theoretical system revealing the universal laws of natural movement, technological development and human-nature interaction, provides a fundamental philosophical methodology for solving the practical problems of modern logistics systems. Based on the basic viewpoints of materialist dialectics, this paper systematically analyzes the dialectical unity relationship between man and nature in logistics activities, explores the internal contradictory movement laws of logistics system evolution, and discusses the negative effects of one-sided mechanical view of nature on traditional logistics development. Combined with real industry data and typical enterprise cases, this paper sorts out the practical application of dialectical thinking in green logistics optimization, digital supply chain reconstruction and logistics system resilience improvement. The research finds that the high-quality development of modern logistics essentially relies on the guidance of dialectical thinking: adhering to the holistic view to optimize the overall layout of logistics systems, adhering to the contradictory view to resolve the development dilemmas of logistics industry, and adhering to the developmental view to promote the iterative innovation of logistics technology and management modes. On this basis, this paper summarizes the practical enlightenment of Dialectics of Nature for the sustainable development of logistics engineering and management, aiming to provide philosophical support and methodological reference for the innovative and green development of modern logistics industry.

Keywords: Dialectics of Nature, Logistics Engineering and Management, Sustainable Development, System Dialectics, Green Logistics, Digital Supply Chain.

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1 Introduction

With the in-depth advancement of global economic integration and digital economy construction, the modern logistics industry has evolved from a single transportation and

warehousing service industry into a basic, strategic and comprehensive pillar industry supporting national economic operation. According to the statistical data released by the China Federation of Logistics and Purchasing, the total value of social



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logistics in China reached 335.2 trillion yuan in 2024, a year-on-year increase of 5.3%, and the cost of social logistics accounted for 13.4% of GDP, a year-on-year decrease of 0.1 percentage point. Although the operational efficiency of China's logistics industry has been continuously improved, there are still prominent structural contradictions: extensive logistics operation modes lead to high resource consumption and carbon emission pressure, the rapid iteration of digital logistics technology is accompanied by the alienation of technological tools, and the pursuit of short-term economic benefits restricts the long-term sustainable development of the industry.

Logistics engineering and management is a discipline that applies engineering system theory, management science and information technology to plan, design, optimize and operate logistics systems. Its research objects cover all links of logistics activities such as transportation, warehousing, distribution, packaging and supply chain coordination, and its core goal is to realize the optimal allocation of resources, the improvement of operational efficiency and the coordination of economic, social and ecological benefits. In the process of discipline development and industrial practice, logistics research and management are prone to mechanical and one-sided cognitive deviations: emphasizing technological efficiency while ignoring ecological constraints, focusing on local link optimization while ignoring overall system coordination, and pursuing quantitative growth while ignoring qualitative development. These practical problems are essentially the concrete embodiment of the separation from the dialectical view of nature in the development of human society and industrial technology.

Engels' Dialectics of Nature systematically reveals the universal connection and eternal development laws of nature, clarifies the dialectical unity relationship between human beings and nature, and points out that human transformation of nature must follow the inherent laws of nature, otherwise it will be punished by nature. As a universal scientific methodology, Dialectics of Nature has strong guiding significance for the disciplinary

development and industrial practice of logistics engineering and management. At present, most existing studies focus on technical optimization and management mode innovation of logistics, while few studies explore the underlying philosophical logic of logistics industry development from the perspective of natural dialectics. Based on the theoretical system of Dialectics of Nature, this paper analyzes the internal development laws and practical dilemmas of modern logistics systems, combines typical industrial cases to verify the practical value of dialectical thinking in logistics engineering optimization and management innovation, and puts forward targeted development enlightenment, so as to make up for the lack of philosophical theoretical research in logistics discipline and provide theoretical support for the high-quality development of modern logistics.

2 Theoretical Connotation of Dialectics of Nature and Its Adaptability with Logistics Discipline

2.1 Core Theoretical Connotation of Dialectics of Nature

Dialectics of Nature is a scientific theoretical system formed by summarizing the development laws of natural science and social practice. Its core viewpoints include the view of universal connection, the view of eternal development, the contradictory movement law of things, and the dialectical unity view of man and nature. Different from the mechanical view of nature that regards nature as a static and isolated object, materialist dialectics holds that all things in nature are interconnected and interact with each other, and the internal contradiction of things is the fundamental driving force for their development and evolution.

First, the view of universal connection emphasizes that nature is an organic whole composed of interconnected and interacting elements, and no independent and isolated thing exists. All links and factors in the system restrict and influence each other, and the change of a single factor will drive the overall change of the system. Second, the view of eternal development points out that nature is

in a continuous process of movement, change and evolution, and the development of things follows the law of quantitative change to qualitative change, negation of negation. Third, the contradictory movement law is the core of natural dialectics. The unity and struggle of contradictions promote the continuous self-optimization and evolution of things, and solving practical contradictions is the fundamental way to realize the development of things. Fourth, the dialectical view of man and nature clarifies that human beings are a part of nature, human transformation and utilization of nature must be based on respecting natural laws, and the coordination between human practical activities and natural ecological balance is the basis of sustainable development.

2.2 Internal Adaptability Between Dialectics of Nature and Logistics Engineering and Management

Modern logistics system is a typical complex open giant system, which has highly consistent logical characteristics with the research object of Dialectics of Nature. First of all, the logistics system has obvious holistic and correlative characteristics. The whole supply chain system is composed of multiple links such as procurement, transportation, warehousing, distribution and after-sales service. Each link is an independent subsystem, and the operation state of each subsystem directly affects the overall operation efficiency of the logistics system, which is highly consistent with the universal connection view of natural dialectics.

Secondly, the development and evolution of logistics industry conforms to the developmental view of natural dialectics. From traditional manual logistics and mechanized logistics to modern digital intelligent logistics and green low-carbon logistics, the development of logistics industry has experienced the process of quantitative accumulation and qualitative leap, and constantly breaks through the limitations of traditional modes under the drive of internal contradictions of efficiency, cost and ecology.

Finally, the practical dilemmas faced by

logistics development are essentially the embodiment of contradictory movement. The contradiction between economic benefit and ecological benefit, the contradiction between technological innovation and humanistic management, and the contradiction between global layout and regional development are the core contradictions restricting the high-quality development of logistics industry. Solving these dialectical contradictions is the core task of modern logistics engineering optimization and management innovation. Therefore, introducing the thinking method of Dialectics of Nature into logistics research can effectively break through the limitations of mechanical single thinking and realize the systematic and sustainable development of logistics industry.

3 Dialectical Analysis of Practical Contradictions in Modern Logistics Development

3.1 Contradiction Between Economic Efficiency and Ecological Sustainability

The primary contradiction in the development of modern logistics industry is the opposition and unity between economic benefit pursuit and ecological environment protection. For a long time, the development of China's logistics industry has relied on extensive operation mode, pursuing the maximization of transportation volume and operational efficiency in the short term, ignoring the resource consumption and environmental pollution caused by logistics activities. According to the data of the National Bureau of Statistics, the transportation industry, as the core link of logistics, accounts for about 18% of the national total carbon emissions, among which road transportation carbon emissions account for more than 70% of the total logistics carbon emissions. Traditional logistics management takes cost reduction and efficiency improvement as the single evaluation standard, resulting in phenomena such as repeated transportation, empty load driving and excessive packaging, which not only cause waste of social resources, but also aggravate environmental pollution.

From the perspective of Dialectics of Nature, economic benefit and ecological benefit are not completely opposed, but a dialectical unity relationship. Short-term excessive pursuit of economic efficiency will damage the ecological environment, and the deterioration of ecological environment will in turn restrict the long-term healthy development of logistics industry. On the contrary, adhering to ecological priority and green development can force the optimization and upgrading of logistics operation modes, realize the coordinated development of economic and ecological benefits, and form a positive cycle of industrial development. For example, the centralized distribution mode and new energy logistics transportation mode adopted by e-commerce logistics enterprises have reduced empty load rate and carbon emissions while improving distribution efficiency, which fully verifies the dialectical unity of the two benefits.

3.2 Contradiction Between Technological Instrumental Rationality and Value Rationality

With the rapid development of digital technology such as big data, artificial intelligence, Internet of Things and digital twins, modern logistics has entered the era of intelligent digital transformation. Intelligent sorting robots, unmanned distribution vehicles, intelligent warehouse management systems and other technical equipment have been widely used in logistics links, greatly improving the operational efficiency of the logistics system. However, the extensive application of logistics technology also brings the alienation of instrumental rationality: the industry excessively pursues technical efficiency and data indicators, ignores the humanistic value in logistics management, and even appears the phenomenon of replacing human management with technology in an all-round way.

From the perspective of natural dialectics, technology is the intermediary for human beings to transform nature and serve social development, and technological progress must be based on humanistic value guidance. The essence of logistics engineering

and management is to serve social production and people's livelihood. The application of digital logistics technology is to improve service quality and realize optimal resource allocation, rather than simply pursue technical upgrading. At present, some logistics enterprises blindly invest in intelligent equipment, resulting in excessive technical input and idle equipment resources. Meanwhile, the standardized and rigid technical management mode reduces the flexibility of logistics service and ignores the personalized needs of customers and the labor value of logistics practitioners. This one-sided technical view violates the dialectical unity of technological progress and humanistic value, and restricts the high-quality development of intelligent logistics.

3.3 Contradiction Between Local Optimization and Overall System Coordination

Logistics system is a complex organic whole involving multiple links, multiple subjects and multiple regions. In the traditional logistics management mode, enterprises and management departments often adopt local optimization thinking, focusing on the efficiency improvement of single links such as transportation or warehousing, while ignoring the overall coordination of the whole supply chain and regional logistics system, resulting in the phenomenon of "local optimization and overall non-optimization". For example, in order to reduce warehousing costs, some manufacturing enterprises reduce inventory reserves in a single way, which leads to the increase of emergency transportation costs and the reduction of supply chain stability; some regional logistics departments blindly build logistics parks, resulting in repeated construction of regional logistics infrastructure and waste of public resources.

The view of universal connection of Dialectics of Nature holds that all elements in the system are interconnected and interactive, and local development must be based on overall system balance. The local optimization of logistics single link may break the balance of the overall system, reduce the overall operational efficiency and

resilience of the logistics system. In the context of global supply chain restructuring, the localized layout and global coordination of logistics industry also present obvious dialectical contradictory characteristics. Excessive reliance on global supply chains will reduce industrial resilience, while blind localization and de-globalization will restrict the improvement of logistics resource allocation efficiency. Only by adhering to systematic dialectical thinking can we realize the coordinated development of local optimization and overall progress of logistics system.

4 Practical Application of Dialectical Thinking in Modern Logistics Engineering and Management

4.1 Adhere to Ecological Dialectics to Promote Green Logistics Development

Adhering to the dialectical unity of man and nature is the fundamental principle of modern logistics green transformation. Guided by the ecological view of Dialectics of Nature, the logistics industry has gradually abandoned the extensive development mode of sacrificing ecology for efficiency, and formed a green logistics development system with low carbon, environmental protection and sustainable development as the core. In terms of engineering optimization, logistics enterprises apply systematic dialectical thinking to carry out overall optimization of transportation routes, packaging design and warehouse operation, reducing resource consumption and carbon emissions from the source.

Taking JD Logistics as an example, the enterprise adheres to the dialectical thinking of coordinated development of economy and ecology, and has built a whole-process green logistics system. In terms of transportation optimization, based on big data algorithm and systematic overall planning, it optimizes urban distribution routes, reduces vehicle empty load rate and detour rate. By 2024, JD Logistics' urban distribution route optimization has reduced the average driving distance by 21% per order, reducing carbon emissions by more than 120,000 tons annually. In terms of green packaging, it promotes recyclable turnover boxes and

degradable packaging materials, realizing the recycling of more than 80% of distribution packaging, effectively reducing white pollution caused by logistics packaging. In terms of warehouse operation, it builds green energy-saving warehouses, adopts intelligent energy-saving control systems to reduce warehouse energy consumption, and realizes the coordinated progress of operational efficiency improvement and ecological environmental protection.

From the perspective of dialectical development law, the green transformation of logistics industry is a process from quantitative change to qualitative change. The gradual popularization of green equipment, green technology and green management mode has accumulated quantitative advantages for the industrial ecological upgrading, and finally realized the qualitative leap of logistics development mode from extensive to intensive and green. This fully verifies that adhering to the ecological dialectical view of man and nature's harmonious coexistence is the fundamental way to resolve the contradiction between logistics economic development and ecological protection.

4.2 Adhere to Systematic Dialectics to Optimize Logistics Supply Chain System

Systematic dialectics is the core thinking method to solve the contradiction between local optimization and overall coordination of logistics system. Different from the isolated and static mechanical thinking, systematic dialectics emphasizes the overall relevance, dynamic balance and hierarchical coordination of the system. Modern logistics supply chain management applies systematic dialectical thinking to break the isolated operation mode of single link and single enterprise, and realize the overall optimization of the whole supply chain from procurement, production, transportation to terminal distribution.

In the field of supply chain optimization, closed-loop supply chain management is a typical practice of systematic dialectics. Traditional logistics is a linear operation mode of "production-transportation-consumption-waste", which has the

problems of resource waste and environmental pollution. The closed-loop supply chain takes the whole life cycle of products as the research object, integrates reverse logistics links such as product recycling, remanufacturing and reuse on the basis of forward logistics, forms a circular and closed logistics system, and realizes the cyclic utilization of resources. According to the industry survey data, manufacturing enterprises that implement closed-loop supply chain management can reduce resource consumption by 15%-20% and improve the overall supply chain operation efficiency by more than 10%.

In terms of regional logistics system construction, systematic dialectical thinking guides the coordinated layout of regional logistics infrastructure. The national comprehensive three-dimensional transportation network construction adheres to the overall planning thinking, avoids repeated construction and resource waste, realizes the complementary advantages of road, railway, waterway and air logistics, and improves the overall service capacity of the regional logistics system. This fully shows that only by adhering to the systematic holistic view of Dialectics of Nature, breaking through local limited thinking, can we realize the high-efficiency and coordinated operation of complex logistics systems.

4.3 Adhere to Developmental Dialectics to Promote Intelligent Logistics Innovation

The development law of negation of negation in Dialectics of Nature explains the iterative innovation logic of logistics technology and management mode. The development of logistics industry has experienced the negation and sublation of traditional manual logistics, mechanized logistics and electronic logistics, and finally evolved into modern digital intelligent logistics. In the process of intelligent logistics development, adhering to developmental dialectical thinking can effectively avoid the alienation of technological instrumental rationality and realize the organic unity of technological progress and value rationality.

Modern intelligent logistics construction abandons the one-sided technical supremacy

thinking, and takes "technology empowerment, people-oriented and sustainable development" as the core logic. On the one hand, it continuously applies emerging technologies such as big data analysis, digital twin and blockchain to optimize logistics system operation: digital twin technology realizes real-time simulation and dynamic scheduling of logistics network, blockchain technology ensures the traceability and safety of supply chain goods, and big data algorithm realizes accurate prediction of logistics demand and scientific scheduling of resources. On the other hand, intelligent logistics management adheres to humanistic value guidance, takes improving customer service quality and protecting the legitimate rights and interests of practitioners as the goal, optimizes the human-machine collaboration mode, avoids excessive technological alienation, and realizes the coordinated development of technological innovation, economic benefit and social value.

The iterative innovation of logistics technology fully conforms to the developmental law of quantitative change to qualitative change. With the continuous accumulation of digital technology application experience and the continuous improvement of management mode, the logistics industry has realized the qualitative leap from efficiency improvement to quality upgrading, and the industrial development has shown a spiral upward trend under the guidance of dialectical developmental thinking.

5 Philosophical Enlightenment of Dialectics of Nature for Logistics Engineering and Management

5.1 Establish a Holistic Ecological View to Realize Harmonious Coexistence Between Logistics and Nature

The basic viewpoint of the dialectical unity of man and nature requires that modern logistics development must abandon the anthropocentric mechanical view of nature and establish a holistic ecological view. Logistics engineering design and management practice should take ecological environmental protection as the basic constraint

condition, integrate ecological benefits into the whole process of logistics system planning, design, operation and evaluation, and build a green and low-carbon logistics development system. In the process of logistics infrastructure construction, route planning and operation management, we should fully consider the bearing capacity of natural ecology, avoid excessive damage to the ecological environment caused by logistics activities, and realize the harmonious coexistence between logistics industry development and natural ecological balance.

5.2 Adhere to Systematic Thinking to Improve the Comprehensive Benefits of Logistics System

The universal connection view of Dialectics of Nature requires logistics management to adhere to systematic overall thinking, change the traditional local optimization and fragmented management mode, and realize the overall optimal allocation of logistics resources. In supply chain management, it is necessary to strengthen the collaborative linkage of all links and all subjects of the supply chain, break the information barrier and resource barrier between upstream and downstream enterprises, and improve the overall stability and operational efficiency of the supply chain. In regional logistics development, it is necessary to adhere to overall planning and coordinated layout, realize the complementary advantages of different transportation modes and regional logistics resources, avoid redundant construction and resource waste, and maximize the comprehensive economic, social and ecological benefits of the logistics system.

5.3 Grasp Contradictory Movement Laws to Promote Sustainable Industrial Innovation

Contradictory movement is the fundamental driving force for the development of logistics industry. In the process of industrial development, we should correctly recognize and actively resolve the core contradictions restricting industrial progress. For the contradiction between efficiency and ecology, we should take green technological innovation as the breakthrough point to realize the coordinated

development of the two; for the contradiction between technology and humanism, we should adhere to value rationality to guide technological progress and realize human-machine collaborative development; for the contradiction between local and overall development, we should take systematic optimization as the means to realize the balanced development of local characteristics and overall system progress. By continuously solving practical contradictions, we can promote the continuous self-optimization and iterative upgrading of the logistics industry and realize long-term sustainable development.

5.4 Adhere to Developmental Thinking to Lead Long-term Industrial High-quality Development

The eternal development view of Dialectics of Nature requires the logistics industry to adhere to innovative development and keep pace with the times. Facing the changes of global economic situation, technological iteration and market demand, logistics engineering and management should break the limitations of traditional experience and solidified mode, actively adapt to the new development situation, and carry out continuous innovation in technical means, management mode and development concept. On the basis of inheriting the excellent experience of traditional logistics development, we should sublate the backward development mode, actively layout digital intelligence, green and low-carbon logistics, and promote the logistics industry to continuously move towards high efficiency, high quality and sustainable development.

6 Conclusion

As a scientific world outlook and methodology revealing the laws of natural development and human social practice, Dialectics of Nature has important theoretical guidance and practical value for the disciplinary construction and industrial development of logistics engineering and management. Modern logistics system is a complex open system with dialectical characteristics. The

practical dilemmas such as the opposition between economic benefit and ecological benefit, the alienation of technological rationality and the imbalance of system coordination faced by the industry are all concrete manifestations of violating the laws of natural dialectics.

This paper systematically analyzes the internal adaptability between Dialectics of Nature and logistics discipline, sorts out the core contradictory problems in modern logistics development, and verifies the practical value of ecological dialectics, systematic dialectics and developmental dialectics in green logistics construction, supply chain optimization and intelligent logistics innovation combined with industry data and typical cases. The research shows that the high-quality development of modern logistics industry must take Dialectics of Nature as the guidance, adhere to the holistic ecological view, systematic overall thinking, contradictory movement view and eternal development view, resolve various practical contradictions in industrial development, and realize the organic unity of technological progress, economic development, social value and ecological protection.

In the future, with the continuous deepening of digital transformation and green low-carbon development of the logistics industry, the practical problems faced by logistics engineering and management will be more complex. It is necessary to further apply dialectical thinking to explore the underlying laws of logistics system operation, continuously innovate logistics technical means and management modes, and provide solid philosophical

theoretical support and practical methodological guidance for the sustainable and high-quality development of modern logistics industry.

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