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Research on the Pathways for Empowering Smart Logistics Transformation through New Quality Productivity

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Abstract: This paper examines the pivotal role of new-quality productive forces in the transformation of smart logistics. By integrating advanced technologies such as the Internet of Things, artificial intelligence, and big data analytics, it optimises logistics supply chain management to achieve highly efficient operations. The study first analyses the challenges facing smart logistics within the context of globalisation and diversifying market demands. It then elaborates on the specific applications of new-quality productive forces within smart logistics, encompassing technological infrastructure development, intelligent operational management, and data-driven decision support. Furthermore, this paper proposes four key stages in the transformation towards smart logistics: the technological foundation stage, the intelligent operational management stage, the data-driven decision support stage, and the organisational culture and management model transformation stage. Research indicates that through the integration of technological and managerial innovation, new-quality productive forces can significantly enhance the efficiency, flexibility and market competitiveness of smart logistics systems.

Keywords: Smart Logistics; New Quality Productivity; Transition Pathway

1. Introduction

With the deepening development of the digital economy and the accelerated restructuring of global supply chains, the logistics industry is entering a critical phase of transformation and upgrading. Traditional logistics models face significant bottlenecks in addressing diverse demands, reducing operational costs, and enhancing responsiveness. Smart logistics has thus emerged as a vital pathway for driving high-quality development within the sector. Smart logistics employs technologies such as artificial intelligence, the Internet of Things and big data to achieve automation, intelligence and informatisation within logistics systems, significantly enhancing transport scheduling, warehouse management and customer service levels.

Meanwhile, the concept of ‘new-type productive forces’—an innovative addition to China's current economic theoretical framework—emphasises an advanced form of productive capacity characterised by technological innovation as its driving force, alongside high technology, high efficiency and high quality. Since its introduction, this concept has rapidly been implemented across multiple sectors, becoming a core driver in building a modern industrial system and advancing high-quality development. Within the logistics sector, new-quality productive forces manifest not only through enhanced technological application capabilities but also through the restructuring of industrial organisation, operational mechanisms and management models. The integration of smart logistics with new-quality productive forces not only provides innovative development impetus for logistics enterprises but also serves as a pivotal fulcrum for constructing digital supply chains and enhancing regional economic resilience.

Despite the ongoing advancement of smart logistics technologies, the practical transition still faces challenges such as unclear pathways, insufficient coordination of key elements, and regional development imbalances. Therefore, systematically examining the enabling mechanisms of new-type productive forces for smart logistics, and exploring its transformation pathways and phased evolution process, holds significant theoretical and practical importance for advancing the digital transformation of the logistics industry and enhancing the development level of China's modern logistics system.

2. Theoretical Foundations and Literature Review

New-type productive forces, as a strategic concept underpinning China's drive for high-quality development, represent a systematic restructuring of traditional productive forces within the context of digital technology-driven innovation and intelligent manufacturing. Its essence manifests not only in the upgrading of labour and technological elements but also emphasises the profound integration and collaborative innovation among these elements[1]. Smart logistics essentially represents the concrete manifestation of new-type productive forces within the logistics domain. Its core objective lies in leveraging technologies such as the Internet of Things, artificial intelligence, and big data to enhance the information transparency, operational efficiency, and service responsiveness of logistics systems, thereby constructing a highly collaborative, flexible, and controllable supply chain network[2].Within the logistics sector, the advancement of productivity manifests as a transition from traditional labour-intensive, experience-driven logistics models towards intelligent logistics systems characterised by digitalisation, networking, and smart capabilities.

Overseas research has predominantly centred on the technological application frameworks and system performance of smart logistics, emphasising its strategic role in urban operations, resource optimisation, and green, low-carbon development. Shee et al. demonstrate through empirical data that smart logistics significantly enhances a city's sustainable operational capacity, exhibiting strong correlations in alleviating traffic congestion, improving delivery efficiency, and controlling carbon emissions. Ding et al. established a theoretical framework for IoT-driven intelligent logistics systems through a review study, emphasising that the synergy among the perception layer, network layer, and platform layer plays a pivotal role in enhancing the intelligence of logistics decision-making[3]. Paužuolienė et al., using Lithuanian logistics enterprises as their sample, empirically demonstrated the comprehensive advantages of smart logistics technologies in enhancing employee labour efficiency, service quality, and operational cost control[4]. They further indicated that technological integration capabilities determine the implementation effectiveness of smart logistics systems[5].

Domestic scholars have primarily conducted research in three areas: the synergistic relationship between new-quality productive forces and smart logistics, development pathways, and regional disparities. Zhuang Weiqing et al. developed an evaluation framework encompassing dimensions such as industrial foundations, technological innovation, and organisational coordination. Their findings reveal significant spatial heterogeneity in the coupling and coordination levels between smart logistics and new-type productive forces, exhibiting an east-high, west-low agglomeration pattern with regional disparities widening annually.Hu Yongqiang et al. employed the entropy method and TOPSIS model to assess the level of new-type productive forces within the logistics sector across China's 30 provinces, They identified that structural disparities, resource endowments and policy environments collectively determine regional development differences, with the eastern region consistently maintaining a leading position[6]. Hao Chengwen employed an intermediary effect model to empirically analyse the mechanism through which smart[7] logistics influences new-type productive forces, concluding that reduced transaction costs and enhanced market integration constitute the pivotal variables linking the two[8].

In the realm of pathway research, Sun Lijun proposes that the modernisation of logistics should be advanced through coordinated efforts in institutional design, platform development and talent support, thereby enhancing the capacity of smart logistics to underpin new-quality productive forces.Xiong Jianyong et al., focusing on rural logistics, highlighted significant shortcomings in infrastructure, talent supply and digitalisation within rural areas[9]. They proposed adopting differentiated approaches to extend smart logistics systems to these regions.Shi Yu emphasised that, from the perspective of supply chain four-stream coordination[10], achieving systematic optimisation of logistics flow, information flow, capital flow and commercial flow within the new productive forces environment constitutes a key strategy for enhancing a company's overall competitiveness[11].

3. New Quality Productivity Empowering the Transformation Path of Smart Logistics

The transformation of smart logistics is not merely a process of technological replacement, but a systemic transformation involving the reconstruction of productive forces. New-quality productive forces, characterized by high technological intensity, strong factor coordination, and high value creation, are fundamentally reshaping the logic of resource allocation and operational models within logistics systems. From the renewal of production factors and the optimization of system linkages to data-driven decision-making and organizational mechanism innovation, new-quality productive forces inject life-cycle-wide momentum into the transformation of smart logistics. On this basis, this paper constructs a four-stage pathway model of "technological foundation – intelligent operations – data-driven decision-making – organizational transformation," systematically revealing the modes of embedding and advancement mechanisms of new-quality productive forces in the transformation of smart logistics.

3.1 Strengthening the Digital Transformation Foundation

The technological foundation stage marks the starting point for smart logistics transformation and represents the pivotal moment when new-quality productive forces first integrate into an enterprise's logistics system. The core task at this stage is to complete the foundational digital infrastructure for the logistics system, including the deployment of IoT sensing devices, sensor networks, GPS positioning systems, and automatic identification and tracking technologies (such as RFID).These devices not only enhance the information collection and transmission capabilities of logistics operations but also enable real-time monitoring and visualised management of processes such as transportation, warehousing, and loading/unloading. Furthermore, a unified information platform and data standards system must be established to provide standardised interfaces for subsequent data integration and collaborative operation across various business systems.At this stage, new-quality productive forces are primarily manifested through the introduction of 'new-quality means of labour'. This entails replacing traditional manual operations and inefficient equipment with high-efficiency, intelligent technological resources, thereby significantly enhancing operational efficiency, reducing operational errors, and laying the groundwork for the integration of higher-level intelligent systems.

3.2 Achieve Integrated Logistics Process Systems

Upon completing the construction of the digital foundation, enterprises advance to the intelligent operations phase. This involves redesigning logistics processes and enabling system integration through advanced information systems and intelligent algorithms, thereby achieving automation and intelligence in business workflows. Key technologies include intelligent transport management systems (TMS), warehouse management systems (WMS), automated sorting systems, unmanned forklifts, and robotic systems. This phase emphasises the organic coordination of data flow, information flow and control flow across all links in the logistics system. Through algorithmic support and platform management, it enhances resource utilisation and operational responsiveness within the logistics network. Building upon this foundation, enterprises are progressively transitioning from traditional 'experience-based decision-making' towards 'intelligent decision-making' underpinned by rules and algorithms. The new-type productive forces at this stage empower 'new-type workers' – versatile professionals equipped with data analysis, system operation and process optimisation capabilities. They will form the backbone of intelligent logistics operations.

3.3 Driving the Intelligent Upgrade of Logistics Decision-Making

As the volume of data accumulating within logistics systems continues to grow, enterprises are progressively transitioning towards a data-driven phase of refined decision-making. Central to this stage is the establishment of a unified data governance architecture and decision support platform. This involves integrating multi-source, heterogeneous data encompassing procurement, inventory, orders, distribution, and customer behaviour to form an enterprise-level data middle platform. Utilising tools such as data mining, machine learning, and predictive modelling, businesses can achieve scientific forecasting and optimised allocation across critical areas including future demand, delivery routes, and inventory turnover. At this stage, data ceases to be merely a tool for recording processes and instead transforms into a critical asset for strategic corporate decision-making. New-quality productivity manifests as the shaping of 'new-quality labour objects' – that is, the conversion of data assets from static resources into dynamic decision-making forces, thereby enhancing the agility and precision of logistics systems.

3.4 Establishing a New Paradigm for Intelligent Logistics Operations

The ultimate transformation of smart logistics relies not only on the updating of technological systems, but also requires profound organisational and managerial changes as its foundation. Traditional logistics enterprises predominantly operate as functional organisations with linear processes, rendering them ill-equipped to adapt to the rapid changes and systemic coordination demanded by intelligent environments. Therefore, the focus during the organisational transformation phase lies in promoting a flatter organisational structure, adopting a platform-based management model, and implementing data-driven cultural mechanisms. Enterprises should establish cross-departmental data collaboration mechanisms through process re-engineering and organisational restructuring, thereby dismantling information silos. Concurrently, they must enhance digital skills training for employees and facilitate a shift among managers from experience-based to data-driven decision-making, comprehensively building a data-centric organisational ecosystem. At this stage, new-quality productive forces manifest as a transformation from 'instrumental capabilities' to 'organisational competencies', becoming the core mechanism driving enterprises towards continuous optimisation, innovation, and adaptation to external changes.

4. Conclusion

Against the backdrop of rapid digital economic development and the deepening technological transformation, smart logistics has emerged as a pivotal pathway for driving the transformation and upgrading of the logistics industry, while new quality productive forces provide its intrinsic impetus and systemic support. This paper constructs a smart logistics transformation pathway based on the core tenets of new-quality productive forces, encompassing the sequence of technological foundation-intelligent operations-data-driven decision-making- organisational transformation. It systematically elucidates the enabling logic and operational mechanisms of new-quality productive forces across distinct developmental stages. Research indicates that the transformation towards smart logistics constitutes not merely an upgrade of technological systems, but rather a fundamental reshaping of organisational structures, decision-making methodologies and management philosophies. This process exhibits distinct characteristics of phased progression, systemic integration and collaborative synergy.

This paper theoretically expands the analytical framework for integrating new-quality productive forces with intelligent logistics, while practically providing a reference pathway for logistics enterprises advancing their digital transformation. However, this paper primarily relies on theoretical induction and lacks empirical data and industry case studies to substantiate its findings. Subsequent research could further focus on constructing an indicator system, exploring differentiated application pathways, and examining the synergistic effects of external policy mechanisms. This would enhance the model's applicability and practical value, thereby promoting the sustainable development of smart logistics across a broader range of scenarios.

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