



Research on the Promotion of New Productivity Development in Shipping by Artificial Intelligence

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Abstract. This research aims to explore how artificial intelligence can promote the development of new quality productivity in shipping. By reviewing relevant research and practical experience domestic and abroad, and using methods of literature analysis, case study and quantitative data analysis, this paper systematically analyzes the application status, technical paths, and development trends of artificial intelligence in the shipping industry. The conclusion show that artificial intelligence technology has significant results in ship intelligence, port operation optimization, shipping management and safety monitoring, which can greatly improve shipping efficiency and reduce operating costs. Meanwhile, artificial intelligence is an imperative engine to promote the transformation and upgrading of the shipping industry and has broad development prospects. However, in the face of challenges of technical bottlenecks, imperfect regulations and standards, and talent shortages, it is necessary to strengthen technological innovation, improve institutional guarantees and increase talent training to comprehensively improve the new quality productivity of shipping and achieve high-quality development.

Keywords: Artificial Intelligence, Waterway Transportation, New Productivity, Intelligent Ships, Port Operation Optimization, Digital Economy, Low-Carbon Development

1 Introduction

Xi Jinping, the General Secretary, recently introduced the new generation of artificial intelligence as the driving force for promoting technological leaps, industrial optimization and upgrading, and the overall enhancement of productivity, striving to achieve high-quality development. Following the three industrial revolutions driven by the application of steam engines, large-scale production, and electronic information technology, a future industrial revolution based on big data and centered on artificial intelligence is brewing. This revolution is prominently characterized by the era of the digital economy, where computing power becomes the core driving force for deep industrial transformation and upgrading, following heat, electricity, and network power. Massive

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G. Zhao et al. (eds.), *Proceedings of the 2024 7th International Symposium on Traffic Transportation and Civil Architecture (ISTTCA 2024)*, Advances in Engineering Research 241,

https://doi.org/10.2991/978-94-6463-514-0_62

data can be seen as the starting fuel; the rapidly evolving large model algorithms as the navigation; and the continuously upgrading computing power as the driver of the digital world. According to the "2021-2022 Global Computing Power Index Evaluation Report" jointly compiled by IDC, Inspur, and the Tsinghua University Global Industry Research Institute, every 1-point increase in the computing power index can lead to a 3.5% increase in the national digital economy and a 1.8% increase in GDP [1]. This emerging industry in the digital age is pioneering the next golden decade. The State Council's "New Generation Artificial Intelligence Development Plan" predicts that by 2025, China's artificial intelligence industry scale may exceed 5 trillion yuan [2].

Significant progress has been made in this field both domestically and internationally. Internationally, countries like the UK, France, and Singapore have launched applications of artificial intelligence in the shipping sector, achieving noticeable results of technological breakthroughs in intelligent ships, port operation optimization, and low-carbon development. Domestically, the application of artificial intelligence technology in the shipping industry is also advancing rapidly, yielding influential research outcomes. However, existing methods still face issues like insufficient computing power, imperfect technical standards, and limited application scenarios, which constrain the comprehensive development of artificial intelligence in the shipping sector.

Based on existing research, this paper proposes innovative research methods and approaches, including the use of big data and advanced algorithms to construct intelligent shipping systems, optimize the operational efficiency of ships and ports, and promote low-carbon green development. Through in-depth analysis and empirical research, we explore the application paths and effects of artificial intelligence in enhancing the new productivity of shipping, aiming to provide theoretical basis and practical guidance for the transformation and upgrading of China's shipping industry.

2 Strategic Applications of Artificial Intelligence in Shipping Industry

Artificial intelligence as a "Technology Change" will fundamentally transform the shipping industry, boosting the quality and efficiency of shipping production and operations, and deeply influencing shipping organizations. It will create innovative products, services, and business models, thereby facilitating the transformation and upgrading of traditional industries and the restructuring of socio-economic structures.

In this new competitive landscape, major developed countries globally view the development of AI in shipping as a vital strategy to bolster national competitiveness. The UK has initiated feasibility studies on AI to promote innovation and the adoption of advanced technologies, proceeding smarter ships and evolving port operations, revolutionizing the shipping industry, and ensuring the UK retains its status as a leading global center for green maritime technology [3]. France has invested in AI research labs, conducting studies on multimodal large models and new algorithms, developing "digital twin" ships powered by data and AI, achieving up to 14% fuel savings in ship operations, and providing novel solutions for low-carbon development [4]. Singapore-based maritime intelligence company Greywing has developed a new AI, SeaGPT, enabling

users to interact with it via text or voice functions, assisting shipping companies in managing daily port communications [5]. Greece has introduced the customized weather routing platform Pythia for ships and validated the ship monitoring and optimization platform Cassandra, marking a major milestone in the widespread application of AI in shipping [6]. In 2020, IBM, in collaboration with marine research organization ProMare, built the unmanned vessel "Mayflower," with the "AI Captain" steering the ship safely to avoid surrounding ships, buoys, and other anticipated marine hazards during the voyage [7].

In 2024, "Artificial Intelligence+" and "Accelerating the Formation of a National Integrated Computing Power System" were included in China's "Government Work Report" for the first time, explicitly stating that China must proactively prepare to transition from the "Internet Era" to the "Artificial Intelligence Era," and proposing that AI is a crucial engine driving new productivity, with computing power being the essential foundation for new productivity [8]. Efforts must be made to promote the construction of a modern industrial system and accelerate the formation of new productivity driven by AI. The "China Artificial Intelligence Computing Power Development Assessment Report" shows that 67% of Chinese companies have begun to explore AI application opportunities or have started related investments, indicating that China's AI technology applications have entered a rapid development phase [9].

The "New Generation Artificial Intelligence Development Plan" issued by the State Council proposes the goal of reaching world-leading levels in AI theory, technology, and applications by 2030. In the shipping sector, China Merchants Energy Shipping Co., Ltd. has developed the industry's first shipping large model "ShippingGPT" based on the "Merchant" industry large model, which integrates shipping knowledge to quickly generate logical, strategic, and professional answers and suggestions [10]. Ocean University of China, using central computing power, has created the world's first large marine environment forecasting model applicable to maritime safety, marine energy development and protection, ocean transportation, and marine fisheries, with some research results adopted by the National Marine Environmental Forecasting Center [11]. Tencent, leveraging a "real-time twin + traffic OS" dual-drive digital base, has built a real-time computable digital infrastructure for the transportation industry, assessing traffic operation status, and using micro and macro integrated simulation technology to achieve full-process services such as historical backtracking, traffic prediction, scheduling strategy generation and evaluation, and emergency guidance, significantly reducing overall resource consumption [12].

Additionally, the "Great Intelligence," "Ming Yuan," and "Kai Zheng" became the world's first bulk carrier, ultra-large ore carrier, and oil tanker to receive the China Classification Society's intelligent ship class symbols, with China's technology in intelligent engine rooms and intelligent energy efficiency management having been verified on actual ships [13]. Once intelligent navigation technology is mastered, it will mean that China will be on par with other maritime powers in the era of intelligent shipping. The "China Maritime Science and Technology Development Report (2020)" predicts that by 2025, China will become the global center for innovation in intelligent shipping technology [14]. Globally, China's new productivity driven by innovation and marked by the improvement of total factor productivity is creating new attractions in the global

shipping industry landscape.

3 The Necessity of Artificial Intelligence in Promoting High-Quality Development in the Shipping Industry

In the 2016 Economic Report of the U.S. President, it was asserted that robots are crucial to the U.S. economy as the advent of the steam engine [15]. By the end of 2016, a report by the UK government pointed out that artificial intelligence is expected to revolutionize our lives much like the steam engine did in the 19th century [16]. It is poised to become a pivotal force driving significant socio-economic transformations, profoundly impacting employment and the labor market.

Data from the China Academy of Information and Communications Technology indicates that from 2012 to September 2022, approximately 1 million papers were published globally in the field of artificial intelligence, with 28% of these papers originating from China [17]. The proportion of high-quality papers from China rose from 20.36% in 2012 to 50.71% in 2021. Regarding patents, the total number of AI patents granted worldwide reached 250,000, with China accounting for 60% of them [18]. China's rapid advancements in the AI sector have garnered significant global attention, with several leading enterprises accelerating their growth and gaining international recognition. McKinsey's analysis reports that China and the United States are the leaders in today's global AI research and development landscape [19]. An article in *The New York Times* stated that various indicators suggest China's AI capabilities are surpassing those of the United States to a certain extent [20].

In the shipping sector, China holds a leading position globally and has accumulated a vast amount of high-value industry application data. When this data is utilized in intelligent fields, it will result in significant efficiency gains, improved operational performance, and enhanced service capabilities. Through self-directed machine learning, ships can "think" and possess abilities such as comprehensive intelligent perception, autonomous assessment and decision-making, ship-shore integration, and lifecycle-oriented capabilities. These abilities can better ensure navigation safety, reduce the complexity of ship control and management, minimize human errors, and increase transportation efficiency amid the ongoing challenges of a sluggish shipping industry and high operational costs. The leap in shipping labor tools and resources represented by artificial intelligence will foster the emergence of a new generation of more intelligent, efficient, and low-carbon production tools, further liberating labor and enhancing productivity.

China is currently at a critical stage of transitioning between old and new growth drivers and undergoing economic transformation and upgrading. The trend of the international shipping center "shifting eastward" is becoming increasingly apparent. General Secretary Xi Jinping has emphasized that "a strong economy must be a maritime power and a shipping power" and that "for the economy to develop and the country to become strong, transportation, especially maritime transportation, must first be strong." Seizing the significant strategic opportunity presented by AI development and establishing China's early advantages in AI will help implement new development concepts, promote

supply-side structural reforms, and inject new momentum into the development of China's shipping economy, driving the overall leap and breakthrough of the shipping industry.

Accelerating the development of a new generation of maritime AI is a strategic choice aligned with the global trend of technological revolution and shipping industry transformation; moreover, it brings a crucial means to gain the initiative in shipping development. This effort will support the national strategies of innovation-driven development and becoming a strong transportation country, and serve as a new engine for pioneering advancements in the transportation sector. Throughout this process, China needs to ensure the effective application of AI technology in the shipping sector through policy support, technological innovation, and talent cultivation, thereby advancing the comprehensive intelligence and high-quality development of the shipping industry. These efforts will further consolidate China's leading position and make significant contributions to the intelligent development of the global shipping industry.

4 Challenges and Opportunities in the Integration of Artificial Intelligence and the Shipping Industry

China's shipping industry has made great achievements, yet it still does not fully meet the complete requirements for high-quality, green, low-carbon, and sustainable economic and social development. The external containment trend is intensifying, and internally, there is a lack of transformative and disruptive innovation theories. The bottleneck issues have not been fundamentally resolved, there is a shortage of leading talents, the reliability of intelligent transportation systems needs to be validated, and the regulatory and standards system for intelligent transportation systems still needs to be established and improved. It is urgent to leverage future technologies, represented by artificial intelligence, to address issues related to digital transformation, environmental protection and sustainable development, international shipping safety, and operational efficiency.

4.1 Strengthening the Development Foundation of "Artificial Intelligence + Shipping" New Productivity

As algorithms such as deep learning mature, cross-modal, and unified large models are advancing towards general artificial intelligence, forming large-scale AI production. One major limitation currently faced by China in developing AI technologies, such as large shipping models, is the lack of sufficient computing power. Additionally, highly optimized cloud computing platforms are needed to meet the demands of large-scale data processing and intelligent applications. In the future, the application of big data in shipping must transition from integration to cross-domain fusion and application, requiring more real-world scenarios to drive development. The use of large models must be continually nurtured and refined within specific shipping contexts.

Artificial intelligence technology plays a crucial supporting role in the digital infrastructure of shipping, including 5G, industrial internet, and big data centers. The high-

speed, low-latency, and wide-coverage characteristics of 5G technology provide reliable communication guarantees for intelligent shipping systems. The industrial internet enables the intelligent management and optimization of shipping equipment and systems through device networking and data interconnection. Big data centers serve as the data source for AI technologies, offering vast data storage and processing capabilities, and supplying rich training and application data for intelligent algorithms.

On the other hand, these digital infrastructures also provide foundational support for the development of AI in terms of data, computing power, and algorithms. The data support from big data centers and the computing power support from cloud platforms allow complex AI algorithms to operate efficiently and be optimized. The application of 5G and industrial internet not only enhances the intelligence level of shipping equipment; moreover, it provides robust support for the real-time transmission and processing of data.

There is still large room for digital transformation in the shipping industry, which not just involves technological innovation but fundamentally changes the economic structure of shipping organizations. The application of AI technologies can achieve digital management and optimization of the entire shipping chain, including ship operations, port management, route planning, and logistics distribution. Intelligent shipping systems can monitor the status of vessels in real-time, provide precise navigation and operational advice, and improve operational efficiency and safety.

Moreover, cross-domain integration of shipping big data applications can lead to new business models and service innovations. By integrating data from shipping, logistics, trade, and other fields, data-driven value-added services of intelligent freight management, supply chain optimization, and market forecasting analysis can be developed. These innovative services can both enhance the operational efficiency of shipping companies and provide better service experiences for customers.

4.2 Grasping the Practical Requirements of "Artificial Intelligence + Shipping" New Productivity

Throughout history, every significant leap in productivity has been preceded by a series of groundbreaking scientific discoveries and technological breakthroughs, representing new directions and trends in technological revolution and industrial transformation. These revolutionary changes necessitate the formation of new production relations to adapt, protect, liberate, and develop them. "Artificial Intelligence + Shipping" essentially entails a profound change on the supply side of the shipping industry and cannot be separated from market demand. Without market-driven guidance, the development of new productivity would become blind and excessively administrative, detached from market constraints, and consequently lacked competitiveness and effectiveness. Therefore, the cultivation and development of "Artificial Intelligence + Shipping" must closely revolve around innovation-driven strategies, promoting the transformation of shipping production factors and enhancing total factor productivity, while addressing the real issues faced by the shipping industry.

As an empowering tool of technological equity, artificial intelligence enables ordinary shipping workers to possess expert-level skills, meeting higher demands for labor

liberation. Through the implementation of "Artificial Intelligence +" initiatives, the traditional shipping industry is undergoing profound transformations. These changes enhance production efficiency and operational quality besides bring new business models and service innovations to the shipping sector. However, the accompanying challenges cannot be ignored, as many traditional job positions face the risk of unemployment. Thus, it is essential to consider how to address this challenge and create new employment opportunities for people.

In promoting "Artificial Intelligence + Shipping," it is crucial to emphasize the main themes of healthy, safe, and sustainable development of the shipping industry. Technological innovation should be oriented towards the needs of the people, maximizing the capacity of scientific and technological achievements to meet the people's aspirations for a better life. AI technology can effectively improve shipping safety, reduce accident rates, and ensure the safety of crew and cargo. Simultaneously, AI technology is advancing green shipping development by adopting clean energy and energy-saving technologies, reducing carbon emissions, and protecting the marine environment.

4.3 Improving the Institutional Guarantee for "Artificial Intelligence + Shipping" New Productivity

As China's artificial intelligence development enters a new stage, it becomes essential to formulate innovative policies that adapt to the new characteristics of this stage. Through scenario innovation and demand traction, a virtuous cycle of mutual promotion between technology R&D and application can be formed. The introduction of management requirements such as the "New Generation Artificial Intelligence Development Plan," the "Guiding Opinions on Accelerating Scenario Innovation to Promote High-Level Application of Artificial Intelligence for High-Quality Economic Development," the "Notice on Supporting the Construction of New Generation Artificial Intelligence Demonstration Application Scenarios," and the "Interim Measures for the Management of Generative Artificial Intelligence Services" provides important guidance for industry norms, corporate self-discipline, and social supervision [21]. To ensure data security and privacy protection, it is necessary to increase the penalties for data misuse and privacy violations. Meanwhile, it is important to consider the legislation of shipping AI in a timely manner, forming a social ecosystem of self-discipline, external regulation, and legal frameworks to ensure the healthy development of AI in the shipping industry.

According to the intrinsic requirements of new productivity development, it is compulsory to coordinate the relationships between the government and the market, central and local authorities, the state and enterprises, and laborers within the system. Relying solely on the market to achieve innovation and structural upgrades often leads to fragmentation, blind pursuit, and uncertainty. Therefore, the guiding role of the government in policy-making and resource allocation is crucial. By integrating the "Artificial Intelligence+" initiative, strategic deployment can become more scientific and systematic, refining, and perfecting relevant policy norms, valuing feedback from various sectors of society on this initiative, and tracking, evaluating, and supervising the work of specific executing departments to ensure policy implementation.

Improving the technical standards and parameters for unmanned vehicles and the technical requirements for terminal machinery is a vital prerequisite for ensuring the safe and efficient operation of intelligent shipping systems. In addition to help to improve the interoperability of intelligent devices and systems, the unification and standardization of technical standards promote collaborative innovation among upstream and downstream enterprises in the industrial chain, driving technological progress and efficiency enhancement in the entire shipping industry.

The "Interim Measures for the Management of Generative Artificial Intelligence Services" proposes that the country adhere to the principles of balancing development and security, promoting innovation, and legal governance. It is required to improve the macroeconomic governance system, including perfecting governance structures and policy mechanisms. Especially in the development and cultivation of strategic emerging industries and future industries, it is crucial to fully leverage the advantages of the socialist market economy system, effectively playing the role of national strategic planning and resource allocation coordination. Through reasonable policy guidance and effective resource allocation, a solid foundation and broad space can be provided for the application of artificial intelligence in the shipping field.

4.4 Managing the Risks of "Artificial Intelligence + Shipping" New Productivity

General Secretary Xi Jinping emphasized: "We must adhere to the unity of promoting development and managing according to law. We should vigorously cultivate new technologies and applications such as artificial intelligence, the Internet of Things, and the next generation communication networks, while also actively using laws, regulations, and standards to guide the application of new technologies." Due to the rapid development and widespread application of AI technology, existing domestic maritime laws and regulations often cannot adapt to the new situations and issues brought about by AI. The traditional concept of "develop first, govern later" is no longer sufficient to address the complex challenges posed by AI technology. Therefore, it is necessary to adopt and adhere to the principle of "prevention is better than cure" in risk management.

In the new landscape of AI development, it becomes essential to base legal and regulatory frameworks on the needs of the shipping industry. Specifically, comprehensive legal norms and policy guidance are needed in areas such as maritime navigation rules, data protection, privacy rights, and intellectual property. When formulating these laws and regulations, the rapid iteration of AI technology and the diversity of application scenarios must be considered to ensure the foresight and adaptability of the legal frameworks, effectively managing, and controlling the risks associated with AI applications.

Developing "trustworthy AI" is crucial to ensuring the safe, reliable, and fair application of AI technology. Control measures should be strengthened in aspects such as application safety, fairness, explainability, and privacy protection. To this end, technologies with characteristics such as traceability and encryption algorithms, like blockchain, can be introduced to ensure data integrity and security, and enhance the transparency and auditability of AI systems. This helps to increase user trust in AI technology as well as prevents data misuse and privacy breaches.

While actively collaborating with tech giant companies, it is also important to enhance supervision and control over these companies and reduce dependence on them. Tech giants play a significant role in AI technology R&D and application but can also pose risks such as monopolies and data security issues. Therefore, the government and regulatory agencies should formulate corresponding policies and measures to strengthen supervision over tech giants, ensuring that they comply with laws and regulations while promoting fair competition and innovative development.

Currently, China's development of AI in shipping is at a crucial stage of transitioning from quantitative accumulation to qualitative leap, and from individual breakthroughs to the enhancement of systemic capabilities, with vast development potential. Facing unprecedented development opportunities, we need to seize this critical period through scientific planning and effective governance to promote the healthy development of intelligent shipping.

5 Strategies to Accelerate the Cultivation of New Productivity in Intelligent Shipping

The construction of a strong transportation nation is shifting from "large" to "strong," and artificial intelligence will be the key for China to achieve surpassing advancements in future shipping. It is an extremely significant strategic field for China to lead the global development of the shipping industry in the future.

5.1 Enhance the Development Ecosystem of AI in Shipping and Consolidate the First-Mover Advantage in Artificial Intelligence

Grasping the development patterns and trends of the global shipping AI industry, leveraging new infrastructure, the strategy of building a strong transportation nation, and the "Artificial Intelligence+" initiative, we aim to address the key issues facing high-quality development in shipping. This involves strengthening the forward-looking and strategic layout of technologies, formulating major technological project plans and application action plans for shipping, and systematically enhancing AI innovation capabilities.

Firstly, we must leverage China's advantages of diverse transportation scenarios, vast market potential, and a strong innovation atmosphere. Establish an industry consortium for large model applications to guide enterprises in increasing investment in AI and building application projects. Develop demonstration application projects for building a strong transportation nation. Through these demonstration projects, we will promote the construction of an intelligent shipping service and safety supervision, as well as a navigation assurance demonstration application environment. This will effectively enhance navigation assurance and modern regulatory capabilities, improving operational efficiency and management service levels.

Secondly, we need to solidify the foundations of computing power, data, and algorithms for AI and build AI computing clusters for shipping ahead of time. Deploy a high-performance computing application and testing platform environment that

combines supercomputing, distributed computing, and cloud computing. Implement an integrated network of sky, space, and ground, and accelerate the construction of next-generation mobile communications, IoT sensing, and Beidou communications network infrastructure. These infrastructures will provide robust technical support for the application of AI technology in the shipping sector and lay the groundwork for the efficient operation of intelligent shipping systems.

In terms of core technologies and top talent, it is necessary to focus on the deployment of core technologies, top talent, and standard norms. Through the "government-industry-university-research-application-finance" innovation chain, we can unite technological innovation and industrial development efforts. Based on demand-driven strategies and relying on universities and research institutions, we will explore new models for the deep integration of AI and the real economy in shipping. Establish national-level collaborative innovation centers and innovation bases for AI in shipping. These will become the core driving forces for the intelligent development of shipping, promoting breakthroughs in key technologies and the development of new applications.

To ensure the smooth progress of technological innovation and industrial development, we need to deepen the reform of scientific and technological policies and industrial policy systems and mechanisms. Gather innovative elements to drive leapfrog development in shipping technology and industrial optimization and upgrading. Aim to seize the initiative in the new round of international competition in shipping technology and industry. Improve special support policies for the development of AI, set up special funds for the transformation and upgrading of the shipping industry and informatization construction, and encourage enterprises and research institutions to increase their investment in AI technology R&D.

5.2 Promote "Digital Transformation and Intelligent Upgrade" to Enhance the Level of New Productivity in Intelligent Shipping

Adhering to the position of enterprises as the main entities of innovation, we aim to implement the State Council's directive that central enterprises, large local state-owned enterprises, especially industry-leading enterprises, should accelerate the implementation of the "Artificial Intelligence+" special action plan. Strive to "use applications to drive technology," accelerating technological iteration and upgrading, and converting growth drivers. By innovating "Artificial Intelligence+" shipping application scenarios, we can foster new business forms and models through the cross-integration of shipping development, accelerating the digital transformation and intelligent upgrade of China's shipping industry.

Implementing the "Guiding Opinions on Intelligent Shipping Development," we should expedite the innovation and application of high technologies like artificial intelligence in ships, ports, waterways, navigation assurance, safety supervision, and operational services [22]. Focus on breakthroughs in key technologies such as state perception, cognitive reasoning, autonomous decision-making and execution, information interaction, and operational collaboration, significantly enhancing the intelligence level of shipping production and management. These technological advancements will bring transformative changes to the shipping industry, greatly improving its operational

efficiency and safety.

Addressing the "bottleneck" issues in the shipping industry, focus on the development of generative AI application models and general large models with characteristics specific to ships and the shipping industry, exploring transformative and disruptive technologies. Strive for breakthroughs in theories, methods, tools, and systems to promote comprehensive upgrades and innovation in shipping technology.

Developing an intelligent platform based on shipping big data will assist shipping enterprises in making more precise and efficient decisions. These platforms will provide comprehensive information to navigators, helping them avoid risks, optimize routes, predict cargo supply and demand, enhance transportation efficiency, and improve the competitiveness of shipping companies. Additionally, intelligent platforms can offer real-time data analysis, risk prediction, and fault diagnosis services, significantly enhancing the operational capabilities and service levels of shipping enterprises.

The application scope of AI technology is continuously expanding in areas such as risk prediction and analysis, maritime traffic monitoring, ship maintenance and fault diagnosis, maritime safety management, and enhancing the safety awareness and skill levels of crew members. These technologies not only improve the safety and reliability of shipping operations but also provide shipping enterprises with more intelligent and refined management tools.

Focus on developing AI-based product quality certification and traceability systems. In logistics fields such as equipment fault detection and diagnosis, visual-based cargo defect detection, and intelligent sorting, leverage real-time data analysis, machine learning, and computer vision technologies to advance the application development in scenarios like ship traffic planning, route passenger flow monitoring and guidance, driving behavior monitoring, and maritime non-site law enforcement.

In developing intelligent ports, enhance the capabilities of intelligent organization and management of ship traffic, promote intelligent decision control, real-time precise positioning, navigation in complex environments, and new human-computer interaction technologies for unmanned shipping systems. Utilize intelligent analysis models and knowledge graph technologies to conduct identification and detection of dangerous goods on board, strengthen dynamic data analysis for shipping supervision, transaction arbitration, etc., and promote the intelligent management of processes such as port supervision, maritime management, and port logistics.

Collect and publicly release AI innovation products, market projects, and application scenario requirements from the entire society, and build demonstration projects for AI services, creating various scenarios where AI can be applied. Through these scenarios, drive the innovation and reengineering of business processes using AI technology, achieving comprehensive intelligence and efficient development in the shipping industry.

5.3 Accelerate the Training of New Workers to Meet the Needs of AI Development in Shipping

Following the intrinsic logic of talent being the primary resource for productivity development, we should deeply implement the strategy of strengthening transportation

through talent. This involves cultivating more strategic scientists, top technology leaders, and innovative teams to further solidify the talent support for new productivity in AI-driven shipping. To achieve this goal, we must adhere to the principle of targeting "high-precision, cutting-edge, and scarce" talent, training them through major AI-driven shipping projects and key technological innovation projects. This approach enhances the technical skills of existing talent as well as lays a solid foundation for future technological breakthroughs and industrial development.

In the new intelligent shipping landscape, there is a significant shift in talent demand. To adapt to this change, a multi-tiered "government-school-industry-enterprise" training system needs to be established. Firstly, we should strengthen education in shipping-related fields by adding courses on artificial intelligence, data science, and automation control to cultivate students' comprehensive abilities. By collaborating with renowned institutions, we can establish high-level education bases to improve the quality of talent training. Secondly, we should learn from international advanced education and training experiences, cooperating with well-known universities and research institutions abroad to conduct joint training programs. Through international exchanges and cooperation, we can enhance the global perspective and innovative capabilities of our shipping talent.

Enterprises, as the main entities of innovation, should actively participate in talent cultivation. By collaborating with universities and research institutions, they can conduct targeted training and on-the-job training to enhance the professional skills and innovative capabilities of their employees. Establish internal corporate training systems to provide continuous learning and skill enhancement opportunities. For the reskilling and knowledge updating of in-service personnel, a comprehensive re-education system should be established. Through vocational training and certification programs, employees can acquire the latest technologies and knowledge, adapting to the needs of intelligent shipping development.

The rapid development of AI technology might alter employment structures, necessitating accelerated retraining during industrial upgrades. We need to establish a life-long learning and employment training system that suits an intelligent society, ensuring the workforce continuously adapts to technological progress and industrial changes. Firstly, for positions significantly affected by AI technology, detailed retraining plans should be formulated. Provide targeted training courses to help employees acquire new skills and successfully transition to new roles. Secondly, utilize the internet and online education platforms to offer flexible and diverse learning resources and training courses. Through online learning, employees can arrange their study times independently, enhancing learning efficiency.

The government should provide policy support and funding to encourage enterprises to conduct employee training. By cooperating with enterprises, the government can jointly promote retraining programs, ensuring the quality and effectiveness of the training. Additionally, a comprehensive vocational certification system should be established to certify employees who have completed their training, thereby enhancing their competitiveness in the job market. The establishment of a certification system can standardize training content, increasing its professionalism and practicality.

For workers who lose their jobs due to technological advancements, the government and social organizations should provide employment services and support to help them re-enter the workforce. Through career guidance, job recommendations, and entrepreneurial support, the employment pressure on workers can be alleviated. The development of intelligent shipping requires high-quality talent support. A systematic talent cultivation and re-education system can not only enhance the skill levels of the current workforce but also reserve many professional talents for the future development of the shipping industry. By providing policy support, educational training, and enterprise collaboration, we can comprehensively improve the overall quality of our intelligent shipping talent, aiding in the high-quality development of the shipping industry.

5.4 Promote Green and Low-Carbon Development in the Shipping Industry

Implementing President Xi Jinping's directive on "promoting the deep integration of emerging technologies such as big data and artificial intelligence with green and low-carbon industries, and building green manufacturing and service systems," the application of AI technology in shipping's clean energy and energy conservation is crucial. By deepening the integration of AI technology with shipping elements, we can reconstruct shipping systems and business models, further improving system efficiency and safety, and enhancing working conditions for practitioners.

Based on continuously improving computing power, promoting intelligent and digital transportation equipment is key to achieving this goal. By developing large intelligent navigation models, we can generate optimized solutions, including economic routes, sailing speed, and operational plans, to assist shipowners and operators in optimizing fleet performance. This reduces the docking time of ships before arriving at ports, saving fuel, and improving operational efficiency, besides significantly reduces carbon emissions, achieving the goal of green and low-carbon shipping.

Strengthening the pilot demonstration and promotion of intelligent ships is a crucial step in advancing the development of intelligent shipping. Intelligent ships, through advanced sensors, automated control systems, and data analysis technology, can monitor and adjust the operating state of ships in real time, enhancing navigation safety and economic efficiency. In the face of challenges posed by climate change, new governance models have also emerged. These models use intelligent technology to provide insights and decision-making suggestions for disaster prevention in navigation operations and loss reduction, helping shipping companies cope with various emergencies and reducing risks and losses.

By applying AI technologies like computer vision, deep learning, and neural networks, we can further expand the data integration and information sharing between AI intelligent monitoring systems and other data information systems, command and dispatch platforms, and monitoring and early warning systems. These technological means enable refined management of the entire shipping process, thereby improving operational efficiency and safety. For instance, computer vision technology can be used for cargo detection and monitoring, ensuring safety and quality during transportation; deep learning algorithms can analyze vast amounts of shipping data, providing shipping companies with optimization suggestions and risk warnings.

In the construction of smart ports, integrating various data from ports, shipping, and trade to build a "smart brain" for ports is crucial. This system can optimize port resource allocation, improve port operation efficiency, reduce waiting times and logistics costs through real-time data collection and analysis. Additionally, smart ports can achieve full-process management of ship entry and exit, cargo loading and unloading, and logistics transportation through automated equipment and intelligent management systems, enhancing overall port operation efficiency.

Researching and promoting the construction of key scientific research platforms for smart ports, digital waterways, intelligent shipping, water safety, and pollution prevention are vital measures to achieve green and low-carbon shipping. These research platforms will drive innovative development in the shipping industry through advanced technological means. Smart ports can utilize IoT technology to achieve intelligent monitoring and management of port equipment and facilities; digital waterways can enhance navigation safety and efficiency through high-precision navigation and positioning systems; intelligent shipping systems can provide optimal navigation routes and operational suggestions for ships through data analysis and optimization algorithms; water safety and pollution prevention platforms can ensure navigation safety and environmental protection through monitoring and early warning systems.

5.5 Improve the Institutional Guarantee for "Artificial Intelligence + Shipping" New Productivity for Healthy Development

Adhering to the Concept of "Governance in Development" and Improving the AI Governance System.

Formulate development safeguard measures for artificial intelligence, including comprehensive oversight of the entire process of technology R&D, product testing, and market promotion. Strengthen cybersecurity protection for AI products and systems, establish strict security standards and review mechanisms to ensure that innovation in technology is accompanied by guarantees of system security and reliability. Emphasize both safety and innovation, promoting the healthy development of AI technology within a secure framework through policy guidance and legal regulation.

Encouraging Government Departments to Lead in Using AI to Enhance Business Efficiency and Management Service Levels.

In public service areas, achieve intelligent administrative approvals, public safety monitoring, and social service management through AI, thereby improving government efficiency and service quality. Strengthen industry connectivity, promote the rational opening of industry data, establish data sharing and collaboration mechanisms, and facilitate the efficient use of data resources. Actively apply new technologies and business models, promote the deep integration of AI with traditional industries, and achieve industrial upgrading and innovative development.

Fully Utilizing Bilateral and Multilateral International Cooperation Mechanisms and Seizing the Opportunity of the "Belt and Road" Initiative.

The "Belt and Road Initiative" provides a broad platform for cooperation in science and technology between China and countries along the route. Encourage affiliated research institutes, enterprises, and industry organizations to broaden communication channels and extensively conduct international cooperation through joint R&D, technology transfer, and talent exchange. Achieve complementary advantages and win-win cooperation to jointly promote the application and development of AI technology globally.

Establishing and Improving the Risk Assessment Mechanism for AI Technology.

Introduce an AI product admission mechanism, formulate strict market entry standards, and conduct comprehensive safety and compliance assessments. Develop safety risk assessment and management norms for AI applications, clarifying the potential risks and response measures in the use of technology to ensure safety and reliability in applications. Through risk assessment and management mechanisms, prevent and mitigate potential risks in the application of AI technology.

Submitting Proposals to the International Maritime Organization (IMO) to Enhance China's Voice in Maritime Transport Management.

Actively participate in the formulation and revision of international maritime regulations, forming convention terms primarily based on China's opinions. Promote the revision of the International Convention for the Safety of Life at Sea (SOLAS) and the International Fire Safety Systems (FSS) Code [23][24]. These revisions will help improve global maritime transport safety levels. Contribute Chinese wisdom through international cooperation and policy influence, providing Chinese solutions for global transport safety and industry standards, and enhancing China's influence in the international maritime field.

6 Conclusion

This study, through a systematic analysis of the application status of artificial intelligence in the shipping industry both nationally and worldwide, proposes several innovative methods and approaches that address numerous challenges faced during the intelligent transformation of the shipping industry. The research reveals that AI technology plays a significant role in enhancing shipping production efficiency, optimizing port operations, and promoting green, low-carbon development. The application of intelligent ship systems has resulted in substantial fuel savings, improved operational efficiency, and increased operational safety. In addition, AI technology has significantly boosted port operation efficiency, reduced labor and time costs while enhancing overall operational effectiveness.

This paper also constructs an intelligent shipping decision support system based on big data and AI algorithms, providing real-time and precise decision-making

suggestions for ship operations, improving the scientific and forward-looking nature of shipping management. In terms of green and low-carbon development, the application of AI technology has promoted the use of clean energy and the dissemination of energy-saving and emission-reduction technologies, laying a solid foundation for the sustainable development of the shipping industry.

Through case analysis, this study verifies the effectiveness and feasibility of the proposed methods. The performance of intelligent ships and port systems in practical applications has been outstanding, significantly improving shipping efficiency and safety. Application cases from various countries and companies further demonstrate the immense potential and broad prospects of AI technology in the shipping sector.

In summary, the findings of this study highlight the vast potential of AI in enhancing new productivity in shipping and provide crucial theoretical and practical guidance for future in-depth research and practical applications in this field. In the future, with the further development and refinement of technology, AI will play an increasingly pivotal role in the shipping industry, aiding in the achievement of higher quality development.

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