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Exploring the Optimization Paths of Manufacturing Enterprises' Competitive Strategy from the Perspective of AI Empowerment

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Abstract: Currently, the global manufacturing industry is undergoing a new generation of information technology revolution led by artificial intelligence. Although manufacturing enterprises in China play a crucial role in economic development, they generally face bottlenecks such as low production efficiency, low product added value, and insufficient innovation capabilities. In this context, this study deeply discusses the path and mechanism of competitive strategy optimization of AI enabled manufacturing enterprises. Using literature research methods, case analysis methods, and empirical research methods, a theoretical framework and method system for artificial intelligence enabling the optimization of manufacturing enterprises' competitive strategies are constructed. The study proposes optimization paths such as data-driven intelligent perception of strategic environment, intelligent algorithm-driven strategic generation and evaluation, dynamic monitoring of strategic implementation and agile adjustment, and knowledge graph-based analysis of competitors' situations. It also provides guarantee measures from the aspects of technology and talent. Research shows that artificial intelligence can offer new opportunities for manufacturing enterprise competition strategy optimization, power enterprises more competitive, achieve high quality development.

Keywords: Artificial intelligence; Manufacturing industry; Competitive strategy

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1. Introduction

1.1. Research background

At present, the global manufacturing industry is experiencing a new generation of information technology revolution represented by artificial intelligence, which has profoundly changed the production mode, business model, and industrial ecology of the manufacturing industry. Chinese manufacturing enterprises, as an important part of the manufacturing industry, play a crucial role in driving economic growth, absorbing employment, and promoting innovation [1]. However, Chinese manufacturing enterprises generally face development bottlenecks such as low production efficiency, low product added value, and insufficient innovation capabilities, making

it difficult to meet the increasingly diverse and personalized demands of the market. Most enterprises mainly rely on low-cost competition, product technology content and brand value are low, thus it is difficult to develop competitive new products and cannot keep up with market changes and technological progress in time.

Artificial intelligence has powerful data processing capabilities and learning abilities, which can conduct real-time analysis and processing of various data in the production process, thereby achieving optimization and intelligent control of the production process. In the production design end, artificial intelligence can quickly generate multiple design schemes based on market demands and consumers' preferences, providing strong support for enterprises' product innovation. It can monitor and predict the running status of production equipment in real time, find potential equipment failures in advance, facilitate the workshop to carry out timely maintenance, and avoid the impact of equipment failure on production [2]. In the sales management end, artificial intelligence can also improve the management efficiency and market competitiveness of enterprises. Based on this, this paper analyzes the path for artificial intelligence to empower manufacturing enterprises for high-quality competition, proposes optimizing innovation paths, and promotes the high-quality development of manufacturing enterprises [3].

1.2. Research purpose and significance

This study delves into the paths and mechanisms by which artificial intelligence can optimize the competitive strategies of manufacturing enterprises, and aims to establish a theoretical framework for this. Combining the characteristics of artificial intelligence technology and the actual needs of manufacturing enterprises, a method system of artificial intelligence enabling competitive strategy optimization suitable for manufacturing enterprises in our country is proposed [4].

This research holds significant theoretical and practical importance. From a theoretical perspective, this study contributes to enriching and improving the theoretical framework for the integration of artificial intelligence and manufacturing. In-depth research on artificial intelligence enabling the optimization of competitive strategies for manufacturing enterprises provides new perspectives and ideas for theoretical research on the integration of artificial intelligence and manufacturing. From a practical perspective, this research helps Chinese manufacturing enterprises enhance their competitiveness in the era of artificial intelligence. The research on the optimization of competitive strategy of artificial intelligence-enabled manufacturing enterprises will provide specific practical guidance and suggestions for China's manufacturing enterprises, and help them better respond to the challenges of the artificial intelligence era, seize opportunities, and achieve high-quality development [5].

1.3. Research methods

To achieve the objectives of this study, the following research methods were employed: literature review, case analysis, and empirical research. Review relevant literature at home and abroad to understand the development status, research dynamics, and frontier trends of the integration of artificial intelligence and the manufacturing industry [6]. The previous research results and experiences of others were summarized to provide a theoretical foundation and reference for the conduct of this study. Multiple representative manufacturing enterprises were selected as cases, and in-depth analysis and research were conducted on their practices in optimizing the competitive strategy with the empowerment of artificial intelligence. Summarize successful experiences and practices, find existing problems and deficiencies, and provide practical support for the conclusions of this study.

2. Theoretical foundations and current situation

2.1. The connotation of artificial intelligence empowerment

Artificial intelligence is a new technological science that studies, develops, and applies theories, methods, technologies, and application systems for simulating, extending, and expanding human intelligence. Artificial intelligence can process and analyze a large amount of data quickly and accurately to extract valuable information and knowledge from it. Through continuous learning and training, it improves its performance and capabilities. Based on data and knowledge, it makes intelligent decisions [7]. In the manufacturing industry, artificial intelligence can be applied to production plan scheduling, quality inspection, equipment maintenance, and other aspects. Real-time analysis and optimization scheduling of production orders, equipment status, material inventory, etc., use computer vision technology to conduct real-time detection of products in the production process, based on machine learning to analyze equipment operation data, and construct equipment failure prediction models. In the management and operation links, AI can be applied to intelligent decision support, human resources management, supply chain management, etc. Based on the analysis of upstream and downstream data of the supply chain by artificial intelligence, demand forecasting, supplier selection, logistics optimization, etc. can be achieved, and an agile and efficient supply chain system can be constructed.

2.2. The connotation and types of manufacturing enterprises' competitive strategy

The competitive strategy of manufacturing enterprises refers to a series of strategic decisions and action plans made by manufacturing enterprises in order to obtain a dominant position in the market competition and achieve their long-term development goals. The core of the competitive strategy of manufacturing enterprises is to improve their competitiveness by optimizing their resource allocation and operation management, so as to stand out in the market competition. As shown in **Figure 1**, enterprises build an intelligent manufacturing model, and the system then forms intelligent manufacturing decisions.

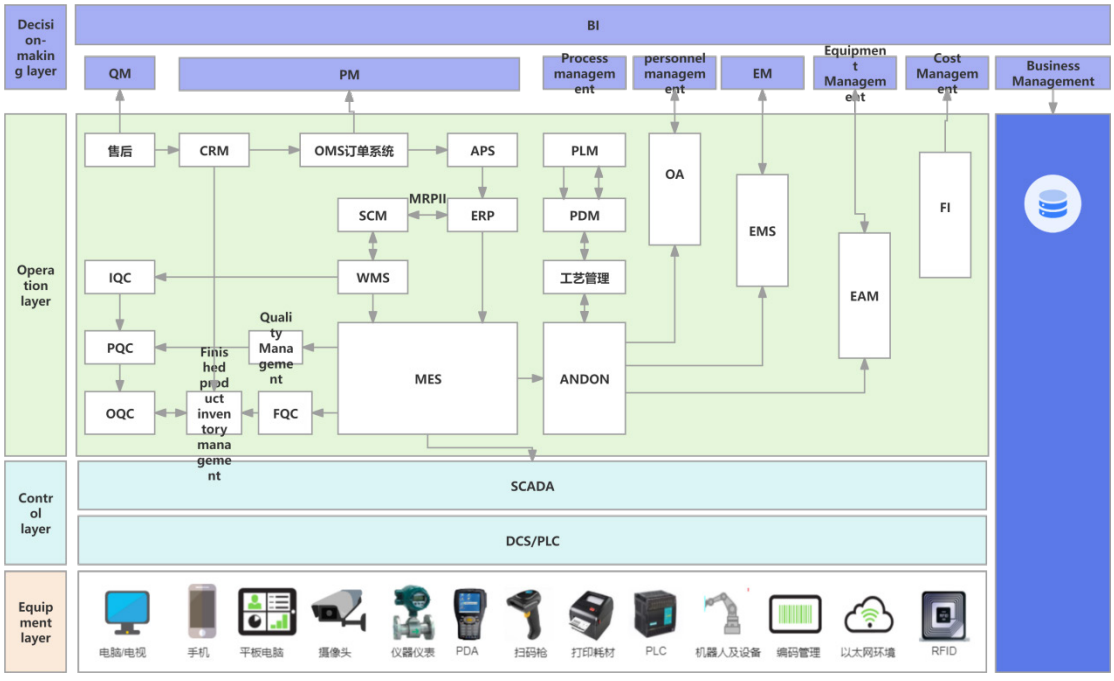

Figure 1. Intelligent manufacturing architecture

Common types of competitive strategies for manufacturing enterprises include the cost leadership strategy,

the differentiation strategy, and the concentration strategy. Among them, the cost leadership strategy means that enterprises optimize their production processes, reduce raw material procurement costs, and improve production efficiency, etc., to lower their production costs. Thus, they can offer products at lower prices and attract price-sensitive consumers. Differentiation strategy refers to enterprises gaining a dominant position in the market competition by providing distinctive products or services to meet the individual needs of consumers [8]. The concentration strategy means that enterprises concentrate their resources on a specific market or product field, and through specialized operation, gain an advantageous position in that field.

2.3. Current situation and problems of strategy formulation in manufacturing enterprises

With the increasingly fierce competition, more and more manufacturing enterprises have begun to attach importance to the strategy formulation work. Many manufacturing enterprises have realized the importance of strategy formulation for enterprise development and actively carried out strategy formulation work. Some large manufacturing enterprises have established specialized strategy formulation departments and have professional strategy formulation teams, which can formulate relatively scientific and reasonable strategic plans [9]. In the process of strategy formulation, some manufacturing enterprises can fully consider the internal resources and capabilities of the enterprise, the external market environment, the situation of competitors, and other factors, and formulate a strategic plan in line with the actual situation of the enterprise. However, many small and medium-sized manufacturing enterprises lack scientific methods and means in the strategy formulation process and often formulate strategies based on experience and intuition, resulting in strategic plans lacking scientificity and feasibility. Although some manufacturing enterprises have formulated scientific and reasonable strategic plans, they lack effective organization and management in the process of strategic execution, which leads to the ineffective implementation of strategic plans. Some manufacturing enterprises fail to timely adjust their strategies according to market changes and the actual situation of enterprise development after formulating strategies, resulting in the disconnection between the strategic plans and the actual market situation. Some manufacturing enterprises lack innovation consciousness in the process of strategy formulation, and often adopt traditional strategic modes and methods, which leads to a lack of competitiveness in market competition [10].

3. Paths for AI to empower competitive strategy optimization

Ningbo Hailian Supply Chain Management Co., Ltd. covers a wide range of business areas including international maritime transportation, air transportation, railway transportation, cargo import and export agency, cold chain transportation, hazardous chemical transportation, third-party trade, and warehousing services. Over the years, the company's business has developed rapidly, transforming from the traditional freight forwarding model to a diversified logistics supply chain service provider, and has established a relatively complete supply chain service system. Currently, it is accelerating its intelligent transformation.

3.1. Data-driven strategic environment intelligence perception

Before launching the AI transformation in the third quarter of 2022, Ningbo Hailian Supply Chain Management Co., Ltd. had already established a well-developed data-driven strategic environment perception system. This is also the basis of the company's AI strategy transformation. After the official launch of the transformation in Q4 2022, the company gradually installed more than 500 sensors in the production workshop and other production scenes to collect production equipment operation data and production environment data in real time. The data collection frequency reaches 10 times per second, and the daily data collection volume is about 100,000 by 2024. The data collection system is connected to the enterprise ERP system and MES system to achieve real-

time synchronization of production data, sales data, and financial data. The data transmission delay is controlled within 1 second, and the data accuracy rate reaches 99.9%. At the same time, the company uses web scraping technology to collect external information such as market data, competitor data, and other external information from the Internet. It collects over 5,000 pieces of various information such as industry news, competitor dynamics, and user reviews every day. Based on statistical analysis, machine learning, and deep learning technologies, the company is able to deeply understand the basic characteristics and laws of data, perform data classification, clustering, prediction, and other analysis, and discover potential patterns and trends in the data. Through modeling analysis of complex data, extracting higher-level features and knowledge, and applying this information to specific operational management links such as market forecasting, competitor analysis, and strategic planning.

As shown in **Table 1**, the AI transformation has significantly enhanced the R&D efficiency of Ningbo Hailian Supply Chain Management Co., Ltd. Through the introduction of intelligent algorithms for strategy generation and solution evaluation, R&D costs as a percentage of revenue fell by 33.3 percent from 15 percent to 10 percent; the size of the engineering team was reduced from 60 people to 20 people, a decrease of 66.7%; while the number of new product R&D increased from 3 to 10, a growth of 233.3%. This fully shows that the application of AI technology not only reduces R&D costs, but also greatly improves the efficiency of R&D output, realizing more innovation results with less resource input.

Table 1. Comparison of R&D processes before and after AI transformation (Q3 2022 vs Q3 2024)

Comparison dimension	Q3 2022	Q3 2024
R&D cost as % of revenue	15%	10%
Engineering team size	60 people	20 people
Number of new products developed	3	10

3.2. Intelligent algorithm-based strategy generation and evaluation

Ningbo Hailian Supply Chain Management Co., Ltd adopts a strategic generation model based on machine learning, applying different machine learning algorithms such as the decision tree algorithm, random forest algorithm, and neural network algorithm to carry out AI strategic decision-making. In Q3 of 2024, the company used 100,000 pieces of historical data for model training, and the accuracy of the decision tree algorithm was 85%, the random forest algorithm 88%, and the neural network algorithm 90%. By using 1 million historical data plus real-time data for model training, the accuracy rate of the decision tree algorithm increased to 92%, that of the random forest algorithm to 95%, and that of the neural network algorithm to 97%. Through continuous adjustment of model parameters and optimization of its structure, the accuracy and reliability of the model were significantly improved. After model training, the company inputs real-time data into the model and automatically generates a strategic plan suitable for the enterprise. By establishing an evaluation index system suitable for the current development stage of the enterprise, the evaluation index and weight are determined from multiple dimensions such as market share growth rate (25%), sales profit rate (20%), return on investment (20%), customer satisfaction (15%), technological innovation ability (10%), brand influence (10%), etc. The generated strategic plan is incorporated into the strategic evaluation index system, and the scores of each indicator are calculated, and the comprehensive score is calculated based on the weights. The strategic plan with the highest comprehensive score is selected as the final strategic plan for the enterprise. After the transformation, the company's strategic plan generation time was shortened from 2 weeks in Q3 2022 to 24 hours in Q3 2024, the evaluation accuracy was improved from 75% to 95%, and the strategic decision-making

efficiency was improved by 1,300%.

As shown in **Figure 2**, the AI transformation has fundamentally changed the production model of Ningbo Hailian Supply Chain Management Co., Ltd. The proportion of standardized production decreased from 90% to 10%, and the time to market of new products shortened from 90 days to 21 days, a reduction of 76.7%; the minimum order quantity has decreased from 10,000 pieces to 100 pieces, a reduction of 99%; and the equipment utilization rate has increased from 65% to 85%, an increase of 30.8%. These changes fully demonstrate the significant achievements of AI technology in optimizing the production process, enhancing flexible production capacity, and improving resource utilization efficiency.

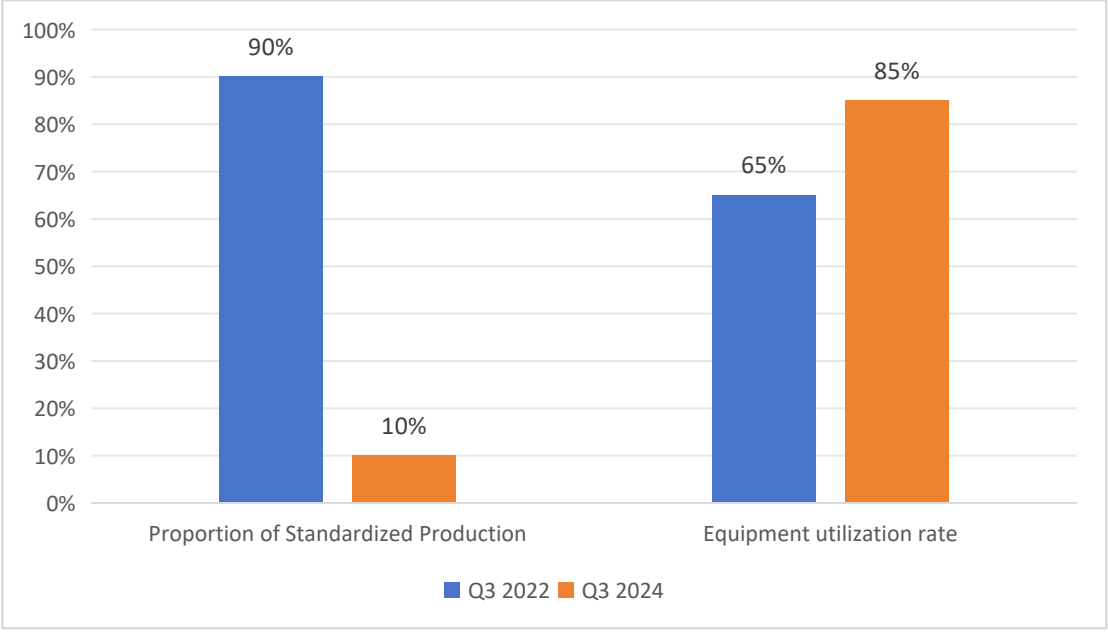

Figure 2. Comparison of production models before and after AI transformation (2022 Q3 vs 2024 Q3)

3.3. Dynamic monitoring-based strategy implementation and agile adjustment

Ningbo Hailian Supply Chain Management Co., Ltd has established a comprehensive dynamic monitoring strategy implementation and agile adjustment mechanism. In the third quarter of 2022, the company set 20 monitoring indicators, and in the third quarter of 2024, it expanded to 50 monitoring indicators. It conducts real-time monitoring and evaluation of the implementation process and results of the strategy, taking into account indicators such as the achievement of strategic goals, the progress and quality of strategy implementation, and the risks and problems encountered during the implementation process. The company has set three-level warning thresholds of red, yellow, and blue, corresponding to deviations of 20%, 10%, and 5% from the target value, respectively. It regularly collects and analyzes monitoring indicator data and promptly identifies problems and risks in the strategy implementation process. When there are red warnings for three consecutive monitoring cycles, or when key indicators fail to reach the target value for six consecutive cycles, the strategic adjustment mechanism is immediately activated, and timely adjustment and improvement measures are taken to ensure the achievement of strategic goals. The company has established a complete strategic adjustment mechanism, adjusting the strategic plan based on the monitoring results of strategy implementation, to ensure the effectiveness and adaptability of the strategy. The trigger conditions, adjustment process, and decision-making authority for strategic adjustment are clearly defined. When the monitoring results of strategy implementation indicate that the strategic plan has problems or risks, all factors are comprehensively considered to ensure that

the adjusted strategic plan is in line with the actual situation of the enterprise and market demands.

As shown in **Figure 3**, after the transformation, the company's problem response time was shortened from 72 hours in the third quarter of 2022 to 4 hours in the third quarter of 2024, and the efficiency of strategic adjustment increased by 1700%, and the achievement rate of strategic goals increased from 65% to 90%.

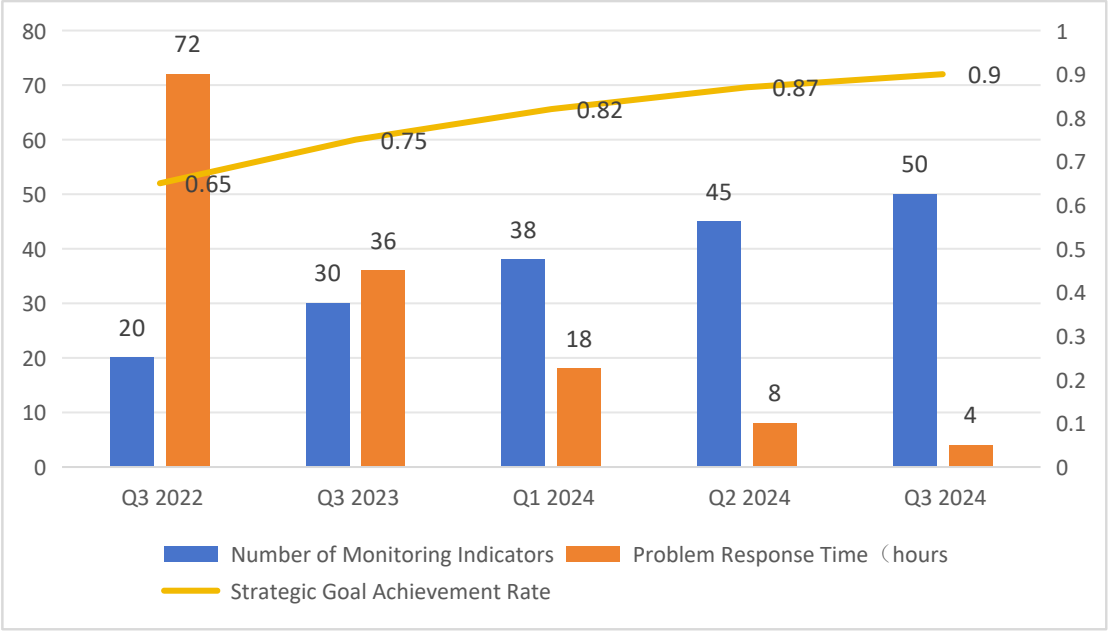

Figure 3. Trend chart of core strategic monitoring indicators of Ningbo Hailian Supply Chain Management Co., Ltd (Q3 2022 to Q3 2024)

3.4. Knowledge graph-based competitor situation analysis

Ningbo Hailian Supply Chain Management Co., Ltd has established a competitor situation analysis system based on a knowledge graph. In Q3 of 2022, the knowledge graph established by the company contains 1000 nodes, and the information of competitors is updated once a month; in the third quarter of 2024, the knowledge graph expanded to 10,000 nodes, enabling real-time updates of competitor information. The company integrated various types of information about related competitors to form a complete knowledge system. Through channels such as the enterprise website, news reports, industry reports, and social media, it comprehensively collected real-time information about competitors, including basic information, product information, market information, and technical information, and cleaned and sorted this information, removing duplicates and invalid data, classifying and annotating it, and establishing relationships between the information. The organized information was stored in the knowledge graph to form a visualized knowledge graph. Through the knowledge graph, companies can intuitively understand all kinds of information and relations of competitors, and have an insight into their strategic intentions, competitive strategies, strengths and weaknesses, etc., so as to provide support for enterprises' competitive decisions.

As shown in **Figure 4**, during the competitor information analysis process, the company adopted diversified combination analysis methods such as SWOT analysis, Porter's Five Forces analysis, and value chain analysis. The accuracy of SWOT analysis increased from 80% to 90%, the accuracy of Porter's Five Forces analysis increased from 82% to 93%, and the accuracy of value chain analysis increased from 85% to 95%. It comprehensively understood the strengths, weaknesses, opportunities, and threats of competitors, analyzed the competitive environment of competitors in the industry, understood the value chain links and value

creation capabilities of competitors, and thus formulated targeted competitive strategies to enhance enterprise competitiveness. After the transformation, the competitor information coverage rate increased from 60% in Q3 2022 to 95% in Q3 2024, the efficiency of competitive strategy formulation increased by 250%, and the market response speed was shortened from 7 days to 2 days. Knowledge graph analysis directly promoted the improvement of market competitiveness; the industry ranking rose from 20th place to 3rd place, the average delivery cycle was shortened from 11 days to 3 days, fully demonstrating the market insight and competitive strategy optimization effects brought by the AI transformation, providing strong support for enterprises to formulate targeted competitive strategies.

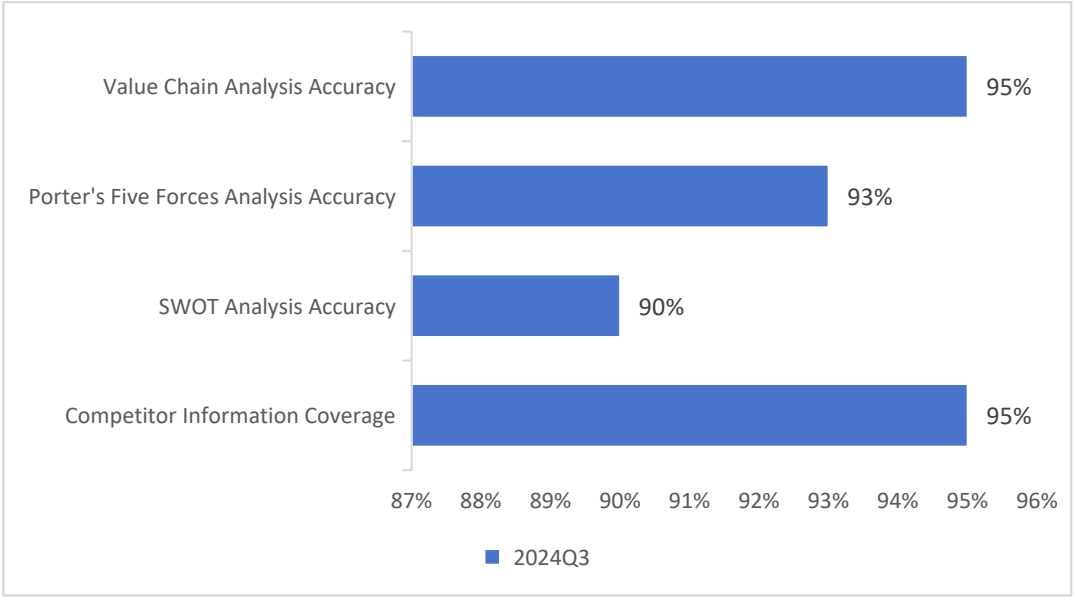

Figure 4. Distribution of core competitiveness analysis capability compliance rate of Ningbo Hailian Supply Chain Management Co., Ltd in Q3 2024

4. Guarantee measures for AI-empowered strategy optimization

Technical support is a crucial pillar for optimizing the competitive strategies of manufacturing enterprises enabled by AI. Enterprises need to increase their investment in the research and application of artificial intelligence technologies, continuously enhancing their technical capabilities and innovation capabilities. Enterprises can establish cooperative relations with universities and scientific research institutions to jointly carry out research and development and innovation of artificial intelligence technology. By fully leveraging the research resources and talent advantages of universities and research institutions, enterprises can accelerate the research and application process of artificial intelligence technologies, improve the accuracy and efficiency of algorithms, and explore suitable artificial intelligence application scenarios and models for the manufacturing industry. They should actively introduce advanced artificial intelligence technologies and equipment from abroad to rapidly enhance their technical capabilities. Strengthen the digestion, absorption, and re-innovation of technology, combine the introduced technology with the actual situation of the enterprise, and form the core technology with independent intellectual property rights.

Personnel guarantee is a key factor for optimizing the competitive strategies of manufacturing enterprises enabled by AI. Enterprises need to cultivate and recruit a group of professionals who are both proficient in artificial intelligence technologies and familiar with manufacturing business, providing talent support for the

application and development of artificial intelligence in the enterprise. They can collaborate with universities, vocational schools, etc., to carry out the training of professionals related to artificial intelligence. Through the establishment of industry-university-research cooperation bases, practice training bases, and so on, to provide students with practice opportunities, improve students' practical ability and employment competitiveness. Enterprises also need to conduct internal training and continuing education to improve the artificial intelligence technical skills and business capabilities of existing employees.

5. Conclusion

Through in-depth discussion on the path and mechanism of competitive strategy optimization of artificial intelligence-enabled manufacturing enterprises, this study draws the following conclusions:

Firstly, artificial intelligence provides new opportunities and means for the optimization of manufacturing enterprises' competitive strategies. Artificial intelligence possesses powerful data processing capabilities, learning abilities, and intelligent decision-making capabilities, which can assist manufacturing enterprises in better understanding market demands and competitor situations, and formulate more scientifically and reasonably competitive strategies.

Secondly, intelligent perception of a data-driven strategic environment, intelligent algorithm strategy generation and evaluation, dynamic monitoring strategy implementation and agile adjustment, and knowledge graph competitor situation analysis are important paths for AI-enabled manufacturing enterprises to optimize their competitive strategy. Through these paths, manufacturing enterprises can realize the intelligent perception of the strategic environment, the intelligent generation and evaluation of strategic plans, the dynamic monitoring and adjustment of strategy implementation, and the comprehensive analysis of competitors' situation, and improve the competitiveness of enterprises.

Finally, technical support, talent support, and data support are important guarantee measures for AI to empower the competitive strategies of manufacturing enterprises. Enterprises need to increase investment in the research and application of artificial intelligence technology, train and introduce a group of compound talents who both understand artificial intelligence technology and are familiar with manufacturing business, strengthen data management and governance, ensure the accuracy, integrity, and security of data, and provide strong support for the application and development of artificial intelligence in enterprises.

6. Research limitations and future directions

This study mainly explored the paths and mechanisms by which artificial intelligence enables the optimization of manufacturing enterprises' competitive strategies from a theoretical perspective, but it lacks sufficient practical case support. Artificial intelligence technology is in a stage of rapid development, and new technologies and applications are constantly emerging. The conclusions of this study may not timely reflect the latest developments and changes in artificial intelligence technology in the optimization of manufacturing enterprises' competitive strategies.

Future research can select more manufacturing enterprises as cases to conduct in-depth analysis and research on their practices in leveraging artificial intelligence for competitive strategy optimization. Pay close attention to the latest developments and changes in artificial intelligence technology, and promptly study the impact of new trends and new applications of artificial intelligence technology on the optimization of manufacturing enterprises' competitive strategies.

Disclosure statement

The authors declare no conflict of interest.

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