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Application of AI technology in the current Chinese manufacturing industry

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Abstract:

Under rapid development of artificial intelligence technology, AI increasingly enters China's manufacturing and is a powerful driving force to drive transformation and upgrading of industries. In consideration of this, taking Alibaba Rhino Factory for an example, in this article, specific use of AI technology in manufacturing and effectiveness will be discussed and analyzed and practice of demand forecasting, smart scheduling, flexible production and testing of quality in Rhino factory, and a conclusion will be drawn with a summary of AI technology's important role in enhancing efficiency in manufacturing, cutting cost and model innovation, and explore current challenge and future development direction.

Keywords: Artificial intelligence, Manufacturing, Rhino factory, Flexible production, Digital transformation

1. Introduction

1.1 background

China is the world's largest manufacturing base. According to the China Internet Network Information Center (2023), it accounts for around 30% of the world's manufacturing output. The industry encompasses a wide range of industries, including electronics, heavy machinery, and textiles. Manufacturing has always contributed to China's economic expansion. However, things are evolving. The world's marketplaces are booming. The cost of labor is rising. Environmental regulations are becoming more stringent. Custom-made items are more popular. Due to these challenges, China must transition from labor-intensive practices to contemporary technology.

This shift is being facilitated by artificial intelligence (AI). It boosts output, enhances quality, and facilitates more efficient use of resources. The way factories operate is being altered by AI technologies like robotics, computer vision, and machine learning. They help make decisions quickly, keep machines from breaking, and adjust production. Machine learning can find equipment problems before they happen and make schedules better. Computer vision can spot defects fast and accurately (Abdelaal, 2024). These tools are changing the industry and competition worldwide.

Manufacturing is changing in a big way. The Fourth Industrial Revolution, called Industry 4.0, is leading the change. This new phase includes AI, the Internet of Things (IoT), big data, and cloud computing. The goal is to make "smart factories." In these factories, machines, systems, and workers stay connected through digital networks (Wang, 2019).

AI is a key part of this change. It helps with automation, accuracy, and flexibility. AI-based maintenance watches machine health all the time. It stops expen-

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sive breakdowns. AI-based supply chain tools manage inventory and cut waiting times (Nelson et al., 2023). These benefits are not just for rich countries. Many places like China are using AI too. But there are problems. High costs, data privacy risks, and not enough skilled workers make AI hard to use. Fixing these problems is important for AI to work well in manufacturing.

Despite its leadership, China's manufacturing are plagued by issues. Over-reliance on foreign nations for essential technologies is one major problem. Over 80% of China's chips are imported, which is quite expensive (State Council of China, 2015). This makes supply networks riskier and hinders the creation of new products.

Product quality is another problem. The failure rate of national products is more than 10%. This leads to economic losses of over 200 billion yuan each year (China Internet Network Information Center, 2023). Old production methods and weak quality control cause these issues.

Energy waste is also a big issue. China's factories use too much energy. The energy use per unit of GDP is almost double the global average (New Economic Guide Journal, 2023). High energy use raises costs and harms the environment. This makes it harder for China to meet its climate goals.

To fix these problems, the government started "Made in China 2025." This plan wants China to be a leader in high-tech manufacturing. It supports AI, robotics, and new materials (State Council of China, 2015). But to make this happen, China must spend a lot on research and help new ideas grow.

AI can help fix many of China's manufacturing problems. It can take over simple tasks and make production smoother. AI-powered robots can do difficult assembly work with accuracy. This cuts down on the need for human workers and lowers mistakes.

First, AI also makes products better. Computer vision systems check products faster and better than people. AI-based tools can find quality problems early. This helps factories fix issues before they become big problems.

Additionally, AI helps factories better use energy and material. Sensors and AI tools track waste and show how to waste less material. This results in a double benefit-cost reduction and environmental protection. These developments help China to pursue its climate goals. Factories generate huge pollution, and using AI to reduce wastage is therefore tremendously important. This study looks at how AI is utilized in factories in China concerning productivity, quality, and sustainability. The key questions are: To what extent is AI applied in China's manufacturing? Does it differ among industries? What are the distinct gains of AI regarding productivity, quality, and cost-saving? What challenges face factories in the use of AI? How do they mitigate these? What lessons can be learned from successful AI use? How could any lessons learned from that be useful to others? Answering these questions will help shed light on the role of AI for the factories. This will provide many useful pointers for the attention of policymakers, business executives, and researchers. This research is significant for several reasons. It takes stock of how AI is being harnessed in China's factories today, noting what has worked and what hasn't. It also documents how AI can help solve some of the key issues of poor productivity, poor quality, and excessive pollution. It gives clear messages. The ideas coming from this study could be important for a policymaker and business leader in making AI work better for factories.

2. Literature Review

2.1 AI in Global Manufacturing Applications

Artificial intelligence has revolutionized manufacturing across the world. Production monitoring, maintenance, procurement, automation, and logistics are improved by AI. In this respect, AI allows real-time decision-making by the manufacturers. Besides, it supports process optimization, particularly in a complex environment such as Nelson, Biddle, and Shapira, 2023. Production become more flexible and efficient.

Smart manufacturing focuses on advances in artificial intelligence technologies such as robotics, computer vision and machine learning. Machine learning is therefore crucial as it helps manufacturers to better schedule production and anticipate equipment problems (Abdelaal, 2024). This guarantees smoother operations and cuts down on the amount of time required for maintenance. Overall productivity rises as a result.

Siemens and General Electric. Both have come up with innovative platforms with extensive use of predictive analytics. The platforms help engineers in operational monitoring and efficiency improvement (Wang, 2019). Overall, their success shows just how important AI is in the fight for competitiveness in manufacturing.

Artificial intelligence drives drastically change the way companies monitor and maintain their machines. And it allows manufacturers to predict any malfunctions that may occur in their machines and perform preventive maintenance. This will not only reduce downtime but also make production continuous. Similarly, an AI system can detect issues in quality a lot earlier and take the necessary steps so that such low-quality goods never reach customers. Therefore, AI can also improve operational efficiency together with product quality. Along with efficiency, AI is making manufacturers flexible. With better production

scheduling now possible because of the power of AI, factories are in a position to respond more rapidly to changes in demand. This is particularly important in cases where a sector one operates within requires small batches or customization of some kind. Solutions related to agile manufacturing are increasingly vital with the rise in consumer demands. AI plays a big role in this flexibility, causing changes at real time in factories.

2.2 Characteristics of China's Manufacturing Industry

China's manufacturing sector, one of the largest in the world, is labor-intensive and already at the center of the supply chain. The China Internet Network Information Center (2023) confirms that "China's manufacturing sector remains an important part of the Chinese economy, accounting for nearly 30% of the world's manufacturing output". This shows how great and enormous the Chinese manufacturing industry is.

Over time, China has gradually moved from traditional and manual to smart manufacturing. It is urgent to deal with such factors as increased labor costs and the high demand for higher quality and personalized products. Indeed, China places a strong emphasis on technological advancement, as evidenced by its push to transition to AI-driven smart factories. According to Shanghai Jiao Tong University's 2024, "China's transition from manual assembly to AI-driven factories is evidence of the country's emphasis on technology and productivity." This transition has already brought benefits to many industries, including improved efficiency, reduced costs, and increased output.

However, besides the many advances, there is still a plethora of challenges ahead for the manufacturing industry in China. Labor shortages are one of the major headaches facing China; the available workforce is aging and young people rarely show interest in working in factories. This no doubt puts much pressure on the manufacturers to resort to technology so as to widen the labor gap. The New Economic Herald 2023 explains, "Chinese manufacturers are resorting to artificial intelligence to overcome labor shortages and improve accuracy.". In this case, the role of AI comes to the fore. Giving manufacturers the opportunity to ensure high production with less labor.

Another challenge is the pressure to improve production efficiency. Many factories still use outdated methods that slow down the production process. These factories must modernise to remain competitive. The use of AI technologies can help address these issues. By improving automation and efficiency, AI can help factories keep up with global demand. AI-driven systems allow factories to adjust production in real time, which is vital for staying ahead in today's fast-paced markets.

2.3 AI Applications in Chinese Manufacturing

AI plays a significant role in various manufacturing industries in improving production, managing the supply chain, and conducting quality checks within China. The China Smart Manufacturing Network points out, "AI-driven solutions improve operational efficiency by 25% while reducing costs by 30%" (2021). This reflects the direct contribution of AI to enhancing the sector.

Key AI technologies such as deep learning and natural language processing are already being used in China's manufacturing industry and they are already playing an important role in China's manufacturing sector. Deep learning is an AI type that works by imitating the functions of the human brain, making it highly applicable in quality control. It detects defects in real time, helping to prevent defective products from reaching consumers, says Deloitte (2018). This reduces the need for human inspection, which can be time-consuming and prone to errors. It applies deep learning technology to quality assurance and accelerates product production by Chinese manufacturers.

Another key AI technology is natural language processing, which improves communication between humans and machines. This therefore makes it easier for workers to interact with AI-driven systems, raising productivity and fewer mistakes. Examples also include automation of tasks previously performed by a human to keep processes running, made possible by AI-driven systems. This reduces costs and speeds up production.

AI is improving not only the production but also helping Chinese manufacturers offer more tailored products. Today, consumers are asking for more personalized products, which definitely AI can help the factories meet. Through analysis of customer data, an AI system can determine which products will be most popular and allow manufacturers to adjust their production schedule accordingly. AI optimizes inventory management and produces just-in-time products and waste reduction that decrease costs.

According to a report from the Chinese Academy of Social Sciences, 2023, AI is industrial in strategic role, since AI "streamlines production, enhances services, and thus enables makers to offer more customized solutions." With intelligent and connected factories, AI will continue to constitute a very important role in shaping the future of manufacturing in China.

2.4 Alibaba Rhino Factory

Alibaba's Rhino Factory is a great example of how AI and digital technology are transforming the apparel manufac-

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turing sector. The factory uses AI and big data to replace traditional production methods with smarter, more flexible systems. These systems allow the factory to produce small batches, customise products, and deliver them quickly.

Rhino Factory has its own intelligent manufacturing platform. This platform automates production processes and improves efficiency. One of its key features is the "chessboard-style hanging" system. This system optimises resource allocation and production line efficiency, making it possible to produce high-quality products quickly and accurately. Rhino Factory has a very flexible production model that allows it to take up small orders as low as 100 units with a delivery time of just seven days. The flexibility helps the factory meet the growing demand for personalized products.The machine can produce up to 400 goods per minute, which enables it to respond quickly to shifting market trends. Big data at the factory further applies in inventory control, production scheduling, and demand forecasting. Rhino Factory manages to keep at minimum levels of inventory and promptly reacts to the market changes with the help of analyzing customer data in real time. It cuts down on operational costs and reduces production cycles.The digital platform connects Rhino Factory to the whole value chain. It eliminates the 'old' middlemen and significantly accelerates production. In addition, with better coordination of design, procurement, manufacturing, and logistics, this online manufacturing platform allows for greater transparency and total production accuracy at each step. The plant has a capacity buffer, and Hard Spike can respond closely to any changes in demand. This minimizes holding costs and production lead times without overproducing and building excess inventory. Rhino Factory is supported in operation on the industrial cloud platform that allows real-time monitoring of production progress, guaranteeing quality, and resource allocation for quicker and more informed decisions to make the production process as effective as possible.

3. Discussion

3.1 Application of AI technology in the manufacturing industry

3.1.1 Popularity of AI technology in China's manufacturing industry

Great progresses have been made in employing AI technology in China's manufacturing industry, particularly in large companies, in which AI technology is extensively applied for process optimization and efficiency improvement. For example, Alibaba's Rhino factory embraced AI technology for smart and automatized production, with a significant improvement in operational efficiency. According to China Intelligent Manufacturing Network (2021), delivery times have been lowered by 75%, and inventories have been lowered by 30% through AI-powered demand forecasting and real-time realignment of production.

3.1.2 AI application case analysis

AI technology, in certain cases, is applied for automatization of production, checking for quality, predictive maintenance, and improvement of supply chains. Alibaba's Rhino factory, for example, utilizes big data and artificial intelligence technology for demand forecasting and rapid realignment of production, with shorter lead times and fewer stocks. In addition, AI technology is extensively applied in industries such as car production, electronic device production and machinery production.

3.1.3 AI application in industries of different sectors

In car production, AI is applied for developing autonomous driving and smart assembly lines; In electronic device production, AI technology is applied for smart checking and high-precision production; In machinery production, AI technology encourages smart production lines and robots.

Application trends and features in industries represent AI technology's general suitability and value.

3.2 Impact and challenge generated through AI technology

3.2.1 The application of AI technology in production and its impact

AI technology brings significant improvement in efficiency in terms of production, goods' quality and cost savings. For one, with AI technology, Rhino factories have attained efficient scheduling and real-time tracking, with 25% improvement in efficiency and 30% in cost savings (China Smart Manufacturing Network, 2021). In addition, AI technology helps companies save materials and maximize customer satisfaction.

3.2.2 Challenge

Application of AI technology, however, brings a challenge of its kind. There is a problem of concern in terms of information privacy, specifically when working with a lot of information about customers. In addition, rapid technological advancement in AI technology brings high demand for AI professionals, but at current times, AI professionals in the marketplace lack demand (Abe, 2021). Finally, smes have high technical obstacles and financial constraints in working with AI technology and require additional guidance in overcoming such obstacles.

3.3 Successful case analysis

The application of AI in China's manufacturing
Example of Alibaba Rhino Factory

3.3.1 . Introduction

Artificial intelligence (AI) technology developed at a high pace in recent years in all over the world, becoming one of key driving powers to drive transformation and upgrading of the manufacturing industry. As a country with strong base in manufacturing, China actively promotes deep integration between AI and manufacturing in an attempt to realize transformation and development from a "manufacturing power" to a "manufacturing power". Alibaba Group's establishment of Alibaba's Rhino Factory is a typical practice in AI technology use in the manufacturing industry, accomplishing flexible production and demand-pull production in apparel with a combination of big data, IoT and AI algorithms. In consideration of this, taking Alibaba's Rhino Factory for an example, in this article, in-depth analysis in detail will be performed about AI technology's use, effectiveness and challenge in China's manufacturing industry.

3.3.2 . Background

Rhino Factory is a smart production platform developed in 2020 by Alibaba, with demand-pull and flexible production in apparel industries in its direction. It aims at utilizing AI technology in overcoming traditional industries' bottleneck such as overstocked inventories, long production cycles, and poor demand forecasting, and providing efficient and cheap production capacities for small and medium-sized brands. Overstocked inventories, long production cycles, and inefficient use of assets have long been a problem in traditional apparel industries. Due to poor demand forecasting, owners of brands will have overhangs in inventories, with increasingly mounting rise in occupancy of capital and operational risks involved. Under traditional manufacturing, long period between design and delivery, it is not simple to follow with quick fluctuations in rapid-changing demand in a rapid-changing environment of fashion. In addition, traditional big-series model brings inefficient use of assets, high cost of production, and high loads in environment. With AI technology, Rhino Factory simplifies whole process between demand forecasting and delivery, providing new solutions for industries.

3.3.3 Application of AI technology in rhino factories

Relying on AI technology, deep implementations in demand forecasting, smart scheduling, production management and checking have been conducted at Rhino Factory. First, in demand forecasting and smart selection, big data (e.g., consumption behavior in Taobao and Tmall) in Alibaba's platform (e.g., consumption behavior in Taobao and Tmall) is analyzed to forecast consumption trends, consumption preference and popular factors through AI algorithms and make future demand forecasts. With such technology, correct model selection, cancelling overhanging inventories and minimizing production risks can be achieved. Next, in smart scheduling and flexible production, AI algorithms dynamically adjust production plans in relation to orders, and schedule production line resource distribution and conduct multi-style and small-batch flexible production. With such a model, production period reduced from traditional months to 7 days, and increased efficiency in the supply chain immensely. In terms of production process management, factories apply IoT technology to monitor production processes and production equipment in real-time, and apply digitalization and automation in overall production processes. Not only will it stabilize and make production efficiency in the production line, but will also reduce human errors and promote production management accuracy. Lastly, in terms of checking, AI visual recognition technology is adopted in checking, and can detect defects and feedback to the production line, promote product quality, and save manpower for checking and inspecting, and reduce its cost.

3.3.4 . Case study

The AI model of Rhino Factory operated remarkably in economy, society, and impact in industries. On one side, through producing in demand and reducing inventories, financial burden incurred through over stocking inventories lessened a lot, and capital turnover of the brand increased remarkably. On a social level, factories have spurred transformation of manufacturing through information technology, and small and medium-sized brands can enjoy relatively low barrier of smart manufacturing service, and react in a flexible way towards changing demand in marketplace. In addition, model of Rhino factory sets an intelligible path of upgrade for traditional industries, and promotes overall development of industries towards smart manufacturing in general. Nevertheless, numerous obstacles hinder AI technology application at present. First, high technical barrier, and AI technology application will require a lot of supporting data and algorithm optimization, and puts high demand on technical capabilities of small and medium-sized companies. Second, adaptability in industries is not high, and current rhino factory is focused in apparel industries, and smart manufacturing model for industries in general is in a stage of exploration. Lastly, precaution must be taken in terms of protecting data and security, and collection and analysis of a lot of big data will cause a risk in protecting data, and puts high

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demand on data management capabilities of companies.

3.3.5 Discussion

The successful practice at Rhino Factory confirms that AI technology has a tremendous range of application in industries of manufacturing. With such integration of approaches including demand forecasting, smart scheduling and checking for quality, AI not only promotes efficiency in production, but even accelerates development of manufacturing towards such aspects such as flexibility, digitalization and intelligence. However, such barriers such as high technical requirements and poor adaptability restrict popularity of AI technology in industries.

3.3.6 Conclusion

Alibaba Rhino Factory is a model case for use of AI technology in China's manufacturing, and its successful practice is an important model for referential use in industries. In future, with technological development and strengthened supporting policies, use of AI in China's manufacturing will become even deeper and broader, injecting new driving force for transformation and upgrade of China's manufacturing sector.

4.Outlines for future development

The future development direction of AI technology in China's manufacturing

AI technology will have an even larger role in China's manufacturing in future, in such emerging industries such as virtual manufacturing and smart factories. With continued development of technology, AI technology will promote development of manufacturing towards a smarter and flexible direction in future years. AI technology will break through in even more industries, such as smart supply chain management and custom-made production with personalized requirements.

Policy recommendation

The government will have to actively promote AI technology popularization through actions including issuing information protection laws, providing financial and technological support, in a move to compel companies to accelerate AI technology application. Besides, the government will have to compel companies to collaborate with universities and technology and finance schools in training additional AI professionals.

Company strategy

For companies, AI talent development, establishment of relations with technology companies, and continued technology innovation investments will become key strategies for future challenges. Companies must pay specific attention to information security and protection of privacy in an attempt to make AI technology application comply with relevant laws and legislation.

Significant progress in AI technology application in China's manufacturing can be noticed, with AI technology being extensively adopted in enhancing processes and improving efficiency in big companies. AI technology application is, however, restricted by information security, talent shortages and technical limitations. In the future, with continuous technological improvement, AI technology will promote development in manufacturing in a smarter and adaptable direction. There will have to be coordination between governments and companies in formulating effective policies and strategies for overcoming such impediments and reaping full advantage of AI technology provisions.

4. Conclusion

The infusion of artificial intelligence into China's manufacturing process answers the common underlying problems that have long plagued the country in its race for competitiveness. China is the biggest manufacturing hub in the world, so the consequences will reverberate widely, invariably affecting China's economy and global supply chains as well. The research investigates the condition of AI within China's manufacturing development, the advantages it affords, and barriers to its implementation. The research establishes that AI has the potential of transforming production processes, enhancing productivity, and supporting sustainable development. Yet, high on the agenda is the critical need to address the array of challenges that this study has unearthed. AI technologies such as machine learning, computer vision, and predictive analytics pose immediate benefits, targeting key issues confronting China's manufacturing sector. These AI technologies enable real-time decision-making, improve asset utilization, and enable better quality assurance. These changes allow manufacturers to achieve improved efficiency and flexibility. For instance, predictive maintenance, enabled through AI, has led to a 30% reduction in equipment downtime. At the same time, systems based on computer vision have raised defect detection rates by more than 20%. These achievements improve performance while keeping pace with demand for customized high-quality products.

However, there are still challenges in adopting AI in China's manufacturing sector. High implementation costs, data privacy concerns, and a lack of skilled workers are major barriers. Small and medium-sized enterprises (SMEs) are especially affected. Additionally, integrating AI with existing systems and processes is complex and expensive. Overcoming these obstacles will require targeted policies, investments in education, and modular AI solutions.

These findings are vital for policy-makers, industry lead-

ers, and researchers. The governments should invest in AI infrastructural development, education, and training to eliminate the skills gap and stimulate growth. They should provide financial incentives and technical assistance to SMEs. Industry leaders should formulate clearly articulated AI strategies in alignment with business objectives. They need to cultivate a culture of innovation and collaboration in order to address the applied challenges in implementation. The future of AI adoption in the Chinese manufacturing sector will stabilize or grow even faster than what is projected. This growth will be primarily propelled by technological, government policy, and market demands for smart manufacturing. Cautionary socio-economic impacts, such as on employment and labor, warrant exploration in future studies. More efforts should be made in this line of research to include ethical guidelines for AI manufacturing. That explores the potential new industries and innovation opportunities: Renewable energies and/or biotechnology; More studies are needed potential explore the power of AI for the new industry covering renewable energies, and biotechnology, where there are high opportunities for innovation.

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