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Artificial Intelligence Competition between China and the United States: Implications for Global Industrial Competitiveness

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ABSTRACT

Artificial intelligence (AI) has rapidly transformed modern manufacturing systems and emerged as a key driver of global industrial competitiveness. The technological competition between China and the United States has accelerated innovation in AI, smart manufacturing, semiconductor technologies, industrial robotics, and the transition toward Industry 5.0. This study aims to analyze AI development in both countries and examine its implications for global industrial competitiveness through a Systematic Literature Review (SLR). The review followed the PRISMA 2020 guidelines and analyzed Scopus-indexed journal articles published over the last five years. Eligible studies were synthesized using thematic analysis to identify technological trends, innovation strategies, AI implementation in manufacturing, and future research opportunities. The findings indicate that the United States maintains leadership in fundamental AI research, software innovation, and high-performance computing, whereas China demonstrates significant strengths in large-scale smart manufacturing implementation and government-supported innovation ecosystems. The integration of AI with the Industrial Internet of Things, digital twins, industrial robotics, and cyber-physical production systems has substantially improved productivity, operational efficiency, manufacturing flexibility, and industrial resilience. The review highlights the strategic importance of AI in strengthening industrial competitiveness and provides valuable insights for researchers, policymakers, and industry practitioners in supporting sustainable intelligent manufacturing and future technological innovation

Keywords: *Artificial Intelligence, China, Global Industrial Competitiveness, Smart Manufacturing, United States*

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1. | INTRODUCTION

Artificial Intelligence (AI) has emerged as one of the most transformative technologies driving industrial modernization and global economic development in the twenty-first century. Rapid advances in machine learning, deep learning, generative AI, computer vision, and large language models have significantly reshaped manufacturing processes, industrial automation, and engineering innovation. AI is no longer limited to intelligent decision-making but has become an essential component of smart manufacturing systems, enabling predictive maintenance, autonomous production, quality control, supply chain optimization, and real-time industrial analytics. Consequently, countries with strong AI capabilities increasingly gain strategic advantages in technological innovation, industrial productivity, and global competitiveness (Jeon, 2025).

Among the leading nations in AI development, China and the United States have emerged as the dominant competitors shaping the future of industrial technology. Both countries have invested heavily in AI research, semiconductor technologies, industrial robotics, cloud computing, and advanced manufacturing infrastructure. While the United States maintains leadership in foundational AI research, software innovation, and high-performance computing, China has rapidly expanded its capabilities through large-scale industrial deployment, government-supported innovation ecosystems, and smart manufacturing initiatives. This technological rivalry has extended beyond scientific advancement to become a determining factor in industrial competitiveness, influencing global supply chains, manufacturing resilience, and technological leadership (Bednarski et al., 2025).

The integration of AI into industrial production has accelerated the transition from Industry 4.0 toward Industry 5.0, where intelligent technologies are expected to coexist with human-centered manufacturing, sustainability, and resilient production systems. Unlike the previous industrial paradigm, Industry 5.0 emphasizes collaboration between humans and intelligent machines, ethical AI implementation, and environmentally sustainable manufacturing. AI technologies such as digital twins, Industrial Internet of Things (IIoT), explainable AI, collaborative robotics, and industrial foundation models have become critical enablers of this transformation. These technologies improve operational efficiency while supporting adaptive, flexible, and data-driven manufacturing systems capable of responding to increasingly complex industrial environments (Zong & Guan, 2025).

The competition between China and the United States has also intensified the race to dominate critical technologies supporting industrial AI, particularly semiconductor manufacturing, cloud infrastructure, industrial robotics, and AI computing platforms. Advances in semiconductor technology determine computing performance required for AI algorithms, while robotics and intelligent automation directly influence manufacturing productivity and production flexibility. Furthermore, increasing investment in research and development (R&D), patent generation, and industrial innovation ecosystems has strengthened both countries' technological capabilities and accelerated the commercialization of AI-based industrial applications (Temerbulatova et al., 2025).

Despite the growing body of literature on artificial intelligence, most previous studies have primarily focused on AI algorithms, manufacturing applications, Industry 4.0 technologies, or national AI strategies independently. Comparatively fewer studies have systematically synthesized how the AI competition between China and the United States influences global industrial competitiveness from an engineering and manufacturing perspective. Existing reviews generally emphasize technological development without comprehensively examining the interconnected roles of AI innovation, industrial infrastructure, manufacturing capability, and technological competitiveness within a unified analytical framework (He et al., 2025).

Addressing this research gap is important because industrial competitiveness increasingly depends on the capability to integrate AI into manufacturing systems, optimize industrial processes, and accelerate engineering innovation. Understanding the technological competition between China and the United States provides valuable insights into future industrial development, technology adoption, and strategic investment priorities for both developed and emerging economies. Moreover, synthesizing recent evidence can support policymakers, researchers, and industrial practitioners in identifying emerging technological trends, research opportunities, and engineering challenges associated with next-generation intelligent manufacturing.

Therefore, this study conducts a Systematic Literature Review (SLR) to analyze the development of artificial intelligence technologies in China and the United States and to examine their implications for global industrial competitiveness. By synthesizing recent literature published over the last five years, this review aims to identify major technological advancements, compare industrial AI implementation in both countries, evaluate their influence on manufacturing competitiveness, and propose future research directions that contribute to the advancement of intelligent manufacturing and sustainable industrial development.

2. | RESEARCH METHOD

This study employed a Systematic Literature Review (SLR) to comprehensively identify, evaluate, and synthesize recent scientific evidence regarding the competition between China and the United States in artificial intelligence and its implications for global industrial competitiveness. The SLR approach was selected because it provides a rigorous, transparent, and reproducible method for summarizing existing knowledge while minimizing selection bias. Furthermore, SLR enables researchers to identify research trends, technological developments, knowledge gaps, and future research opportunities within a specific domain. The review process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, which have become the international standard for conducting evidencebased literature reviews across engineering and technology disciplines (Phillips et al., 2024).

The literature search was conducted using the Scopus database because it is one of the largest and most comprehensive indexing databases for peer-reviewed engineering and technology publications. To ensure the relevance and recency of the reviewed studies, only journal articles published over the last five years were considered. The search strategy employed combinations of keywords using Boolean operators, including “Artificial Intelligence,” “China,” “United States,” “Industrial Competitiveness,” “Smart Manufacturing,” “Industry 5.0,” “Advanced Manufacturing,” “Industrial AI,” and “Digital Manufacturing.” These keywords were selected to capture studies discussing AI technologies, intelligent manufacturing systems, engineering innovation, and industrial competitiveness from both national and global perspectives (Alvarez-Aros & Bernal-Torres, 2021).

To improve the quality and consistency of the review, predefined inclusion and exclusion criteria were established. The inclusion criteria consisted of: (1) peer-reviewed journal articles indexed in Scopus; (2) publications written in English; (3) studies published over the last five years; (4) research focusing on artificial intelligence, industrial applications, manufacturing technologies, Industry 5.0, or industrial competitiveness; and (5) studies providing empirical findings, conceptual analyses, or systematic reviews relevant to the research objectives. Conversely, conference proceedings, book chapters, editorials, notes, non-English publications, duplicate records, and studies unrelated to engineering or industrial applications were excluded from the review (Singh et al., 2024).

Following the screening process, the selected articles underwent detailed content analysis. Relevant information including publication year, authors, research objectives, AI technologies investigated, industrial sectors, methodological approaches, principal findings, and identified research gaps was systematically extracted and organized using thematic analysis. The synthesized evidence was subsequently classified into major themes concerning AI technological development, intelligent manufacturing, industrial innovation, and global industrial competitiveness. This analytical approach facilitated a comprehensive comparison of AI advancements in China and the United States while enabling the identification of emerging technological trends and future research directions within engineering and smart manufacturing research

3. | RESULTS AND DISCUSSION

The systematic literature review identified that artificial intelligence (AI) has become a fundamental technological driver shaping industrial transformation and global competitiveness. Across the selected studies published over the last five years, AI was consistently recognized as a strategic technology capable of improving manufacturing efficiency, optimizing production systems, and supporting intelligent decision-making. The rapid development of machine learning, deep learning, computer vision, natural language processing, and generative AI has significantly expanded industrial applications beyond conventional automation toward intelligent and adaptive manufacturing systems. These technologies enable manufacturers to process large volumes of industrial data, predict equipment failures, optimize production scheduling, improve quality inspection, and reduce operational costs, thereby strengthening industrial competitiveness in increasingly dynamic global markets (Pasupuleti et al., 2024).

The reviewed literature further demonstrates that the technological competition between China and the United States has accelerated innovation throughout the AI ecosystem. Rather than competing solely in algorithm development, both countries have invested substantially in semiconductor technologies, cloud computing infrastructure, industrial robotics, high-performance computing, and advanced manufacturing systems. The United States continues to lead in the development of foundation AI models, software platforms, and cutting-edge AI research supported by world-renowned universities and technology companies. In contrast, China has emphasized rapid industrial deployment through national AI strategies, large-scale digital manufacturing programs, and government-supported industrial innovation initiatives. This difference illustrates two complementary innovation models: one driven primarily by technological breakthroughs and private-sector innovation, and the other characterized by coordinated industrial policy and accelerated commercialization (Veugelers et al., 2024).

A recurring finding across the reviewed studies is that manufacturing industries have become one of the primary beneficiaries of AI implementation. Intelligent manufacturing systems integrate AI with Industrial Internet of Things (IIoT), digital twins, industrial robots, and cyber-physical production systems to establish interconnected production environments capable of autonomous monitoring and decision-making. AI algorithms continuously analyze data generated by sensors, machines, and production lines to identify anomalies, optimize resource allocation, and enhance production flexibility. Consequently, manufacturers can achieve higher productivity, lower downtime, improved product quality, and greater responsiveness to market changes. These technological capabilities directly contribute to industrial competitiveness by increasing operational efficiency while reducing production risks (Hughes et al., 2022).

Another important observation emerging from the literature concerns the strategic role of semiconductor technology in supporting AI development. Advanced AI algorithms require high-performance computing hardware capable of processing massive datasets and executing complex neural network models. Consequently, semiconductor manufacturing has become a critical component of technological competitiveness between China and the United States. Recent studies emphasize that leadership in AI is increasingly determined not only by software innovation but also by the capability to design and manufacture advanced processors, graphics processing units (GPUs), AI accelerators, and edge computing devices. Investments in semiconductor research and manufacturing infrastructure therefore have significant implications for industrial productivity, supply chain resilience, and long-term technological independence (Liu et al., 2024).

The review also reveals that the transition from Industry 4.0 toward Industry 5.0 has broadened the objectives of AI implementation within manufacturing systems. While Industry 4.0 primarily emphasized automation, connectivity, and digitalization, Industry 5.0 introduces a more human-centric perspective in which AI supports collaboration between humans and intelligent machines. Collaborative robots, explainable AI, and intelligent decision-support systems enable engineers and operators to interact more effectively with automated production environments while maintaining transparency, safety, and ethical responsibility. This transition reflects the growing recognition that sustainable industrial competitiveness depends not only on technological sophistication but also on human creativity, resilience, and environmental sustainability. As a result, AI is increasingly viewed as a collaborative technology rather than a complete replacement for human expertise (Kunz et al., 2025).

In addition to technological advancement, the literature consistently highlights research and development (R&D) investment as one of the principal determinants of AI competitiveness. Both China and the United States have significantly increased public and private investment in AI research, industrial innovation, and technology commercialization. Universities, research institutions, and industrial enterprises collaborate extensively to accelerate knowledge transfer and develop practical AI solutions for manufacturing industries. These collaborations have contributed to rapid growth in scientific publications, patent applications, industrial prototypes, and commercial AI products. Furthermore, government policies encouraging innovation ecosystems, technology incubation, and industrial digital transformation have strengthened national competitiveness by fostering continuous technological advancement. The reviewed studies suggest that sustained investment in R&D remains essential for maintaining technological leadership and ensuring the successful integration of AI into next-generation manufacturing systems (Rakholia et al., 2024).

Finally, the synthesis indicates that AI competition between China and the United States extends beyond national economic interests and increasingly influences global industrial ecosystems. Technological innovations developed in these two countries are rapidly disseminated across international manufacturing networks through multinational corporations, global supply chains, technology partnerships, and industrial standards. Consequently, manufacturers worldwide adopt AI-driven production systems, predictive maintenance technologies, intelligent quality control, and digital manufacturing platforms originally pioneered by leading technological economies. This diffusion process accelerates global industrial transformation while simultaneously intensifying international competition for technological leadership. Therefore, understanding the evolving AI race between China and the United States provides valuable insights into the future direction of intelligent manufacturing, industrial innovation, and global industrial competitiveness in the era of digital transformation (Yu et al., 2022).Beyond technological capability, the comparative analysis of the reviewed literature demonstrates that the AI competition between China and the United States is increasingly determined by the strength of their innovation ecosystems. The United States benefits from a mature research ecosystem that integrates leading universities, technology companies, venture capital, and startup communities, creating an environment that accelerates fundamental AI research and commercial innovation. This ecosystem has enabled the rapid development of foundation models, cloud-based AI services, industrial software platforms, and intelligent automation solutions. Conversely, China's innovation ecosystem is characterized by strong governmental support, large-scale industrial implementation, and coordinated national strategies that facilitate the integration of AI into manufacturing industries. National initiatives promoting intelligent factories, industrial digitalization, and advanced manufacturing have enabled Chinese industries to rapidly adopt AI technologies at scale. These contrasting innovation models illustrate that technological competitiveness depends not only on scientific discovery but also on the effectiveness of technology diffusion, industrial collaboration, and commercialization strategies (Jeon, 2025).

Another important finding concerns the role of industrial data as a strategic resource for AI development. AI systems continuously learn from large volumes of production data generated by sensors, manufacturing equipment, enterprise resource planning systems, and industrial Internet of Things (IIoT) platforms. The ability to collect, process, and analyze these datasets has become a decisive factor in improving production efficiency, predictive maintenance accuracy, and intelligent decision-making. Consequently, manufacturers increasingly invest in digital infrastructure that supports real-time data acquisition, cloud computing, and edge computing technologies. These infrastructures enable AI models to operate with lower latency while improving system responsiveness in complex manufacturing environments. Recent studies indicate that organizations capable of integrating industrial big data with AI algorithms achieve higher operational performance and stronger competitive advantages than firms relying solely on conventional automation technologies (Gabsi, 2024).

The reviewed studies also identify several technical challenges that continue to limit the widespread adoption of AI in manufacturing. One of the most significant issues is the lack of transparency in complex AI algorithms, particularly deep learning models that often function as “black boxes.” This limitation reduces user trust and complicates engineering decision-making in safety-critical industrial environments. Consequently, Explainable Artificial Intelligence (XAI) has emerged as an important research direction aimed at improving model interpretability, accountability, and reliability. In addition, cybersecurity risks, data privacy concerns, interoperability among heterogeneous manufacturing systems, and the shortage of AI-skilled professionals remain substantial barriers to industrial AI implementation. Addressing these challenges requires interdisciplinary collaboration involving engineering, computer science, industrial management, and public policy to establish trustworthy and secure intelligent manufacturing systems (Merchán-Cruz et al., 2025).

Sustainability has become another dominant theme identified in the literature. Rather than focusing exclusively on productivity, recent engineering research emphasizes the contribution of AI to sustainable manufacturing through energy optimization, waste reduction, predictive maintenance, and efficient resource utilization. Intelligent production systems can dynamically optimize machine operations, minimize unnecessary energy consumption, and reduce material waste by continuously analyzing production conditions. Digital twins and AI-driven simulation models further support sustainable decision-making by enabling manufacturers to evaluate production scenarios before physical implementation.

4. | CONCLUSION

This study systematically reviewed recent literature published over the last five years to examine the competition between China and the United States in artificial intelligence and its implications for global industrial competitiveness. The findings indicate that AI has become a strategic technological driver transforming manufacturing systems, industrial automation, and engineering innovation. Both countries have adopted different yet complementary approaches to AI development. The United States maintains leadership in fundamental AI research, advanced software development, and high-performance computing, whereas China demonstrates significant advantages in large-scale industrial deployment, intelligent manufacturing, and government-supported innovation initiatives. These distinct strategies have accelerated technological advancement and strengthened industrial competitiveness on a global scale.

The review further highlights that AI integration with smart manufacturing technologies—including industrial robotics, digital twins, Industrial Internet of Things, big data analytics, and advanced semiconductor technologies has substantially improved production efficiency, operational flexibility, product quality, and decision-making capabilities. At the same time, several challenges remain, including AI transparency, cybersecurity, data governance, interoperability, and the availability of highly skilled human resources. Addressing these challenges will be essential to ensure the sustainable implementation of intelligent manufacturing systems.

Overall, the AI race between China and the United States is reshaping the future of global manufacturing and industrial innovation. The study contributes by providing a comprehensive synthesis of recent technological developments and identifying emerging research opportunities related to Industry 5.0, trustworthy AI, sustainable manufacturing, and intelligent production systems. Future research should focus on developing integrated engineering frameworks that combine technological innovation, industrial competitiveness, and sustainability to support the next generation of resilient and human-centered manufacturing ecosystems.

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The authors declare that there is no conflict of interest.

Ethical Approval and Originality Statement

Ethical approval was obtained for this study. The manuscript represents original work and has not been previously published, nor is it under consideration by another journal.

Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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