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DEVELOPMENT OF AUTOMATION IN CHINA'S MANUFACTURING INDUSTRY: CURRENT STATUS, OPPORTUNITIES, AND CHALLENGES

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Annotation. This paper examines the development of automation in China's manufacturing industry, analyzing its current status, driving factors, economic impacts, challenges, and future directions. Leveraging data from the International Federation of Robotics and policy frameworks like "Made in China 2025," it highlights China's dominant role in industrial automation, accounting for 52% of global industrial robot installations in 2022. Key findings include rapid productivity growth, enhanced export competitiveness in intelligent equipment, and challenges such as foreign technology dependence and regional disparities. The study underscores the need for innovation, green manufacturing, and inclusive policies to sustain China's leadership in global industrial automation.

Key words: manufacturing automation, industrial robots, Made in China 2025, labor productivity, regional disparities.

«As the product life cycle, control and compliance requirements for managing the execution process with correct instructions, real-time data and production information increase, a Manufacturing Execution System is needed. With the manufacturing execution system, production and process parameters are recorded and reported instantly by establishing direct connections from production lines and machines. Manufacturing is kept under control by providing real-time access to production values and performance via the Internet at any time» [1, p. 62].

As a global leader in manufacturing, China has achieved remarkable breakthroughs in automation and intelligent technologies in recent years. Unlike developing countries such as Sri Lanka, which rely on labor-intensive industries, China is driving its manufacturing sector toward high value-added and high-efficiency models through technological innovation. This article analyzes the current status, driving factors, economic impacts, challenges, and future directions of automation in China's manufacturing industry, supported by data and case studies.

Current Status of Automation in China’s Manufacturing:

1. Widespread Technological Adoption

China has made significant investments in industrial robots, artificial intelligence (AI), and the Internet of Things (IoT). According to the International Federation of Robotics (IFR), China accounted for 52% of global industrial robot installations in 2022, maintaining its position as the world’s largest market for nine consecutive years (table 1).

Table 1 – Key Data of China’s Manufacturing Automation (2022)

Indicators	Value	Global Share
Industrial Robot Installations	290000 units	52%
Automation Market Size	250 billion	35% (global industrial automation market)

China is by far the world´s largest market. In 2022, annual installations of 290,258 units replaced the previous record of 2021 by growth of 5%. This latest gain is remarkable since it even tops the 2021 result that was a 57% jump compared to 2020. To serve this dynamic market, domestic and international robot suppliers have established production plants in China and continuously increased capacity. On average, annual robot installations have grown by 13% each year (2017-2022).

Robot installations in **Japan** were up by 9% to 50,413 units, exceeding the pre-pandemic level of 49,908 units in 2019. The peak level remains at 55,240 units in 2018. The country ranks second to China in size of market for industrial robots. Annual installations gained 2% on average per year (2017-2022). Japan is the world´s predominant robot manufacturing country with a market share of 46% of the global robot production.

The market in the **Republic of Korea** rose by 1% – installations reached 31,716 units in 2022. This was the second year of marginal growth, following four years of declining installation figures. The Republic of Korea remains the fourth largest robot market in the world, following the United States, Japan, and China [2].

There are annual installations of industrial robots 15 largest markets in 2022 on figure 1.

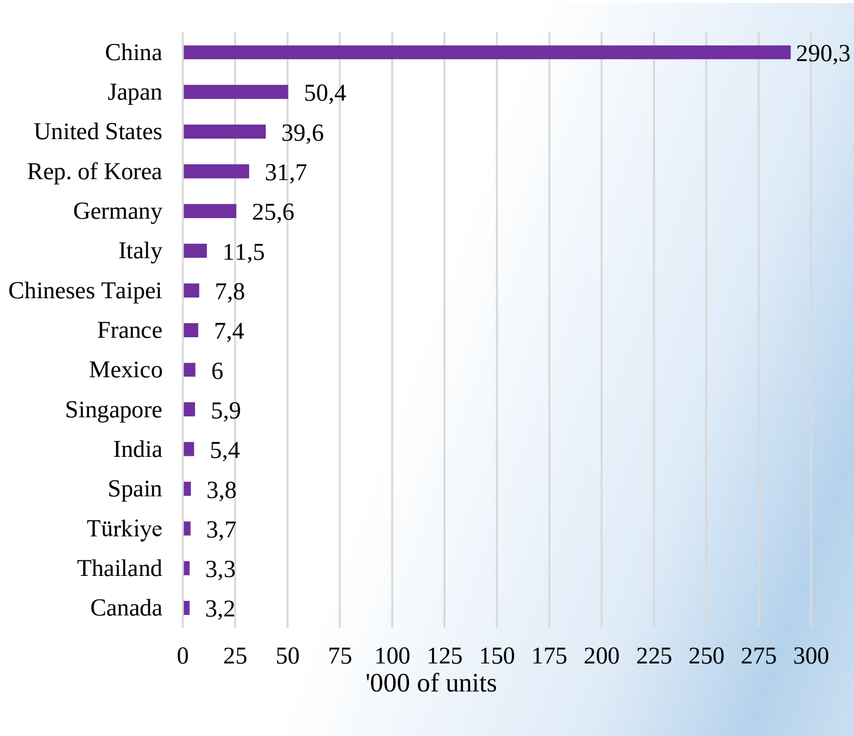

Figure 1 – Annual installations of industrial robots
15 largest markets in 2022
* created by the author based on [3]

China is the world's largest market for robots and automated components, accounting for 25% of the total number of robots in use in 2014.

As for the AI industry in modern China, it is a rapidly developing multi-billion dollar industry. The development of AI in China began in the late 1970s after Deng Xiaoping's economic reforms, which recognized science and technology as the country's main productive force.

Between 2015 and 2019, China ranked third in the world after the United States and the European Union in the total number of peer-reviewed AI publications produced through corporate-academic partnerships. In addition, according to the AI Index report, China has surpassed the United States and the EU in the total number of global citations in AI-related journals in 2023 (81% vs. 75.5% and 75.6%). In terms of AI R&D, peer-reviewed AI articles in China are mostly government-sponsored.

As of 2023, 47% of the world's top AI researchers received their higher education in China.

In 2021, China issued the Data Security Law of the People's Republic of China, its first national law regulating ethical issues in AI interactions. In July 2024, the government opened its first algorithm registration center in Beijing [2].

2. Policy Support

The Chinese government has prioritized intelligent manufacturing through strategic initiatives such as "Made in China 2025", offering tax incentives and R&D subsidies. For example, Guangdong Province plans to establish 100 smart factories by 2025, covering key industries like automotive and electronics.

3. Industry Applications

Automation technologies are widely used in automotive manufacturing, electronics, home appliances, and renewable energy. Tesla's Shanghai Gigafactory, for instance, boasts an automation rate exceeding 95%, with a production cycle of just 45 seconds per vehicle.

Driving Factors

1. Rising Labor Costs

Over the past decade, average wages in China's manufacturing sector have grown by approximately 8% annually, incentivizing companies to replace low-skilled labor with automation.

2. Global Competition

Increasing demands for product quality and delivery efficiency in international markets have compelled technological upgrades.

3. Technological Advancements and Industry Synergy.

Domestic companies like Huawei (5G) and DJI (drones) have driven technological synergy: Huawei's 5G enables real-time industrial IoT data transmission, improving production line efficiency by 15% in smart factories such as those of Foxconn.

Economic Impacts

1. Enhanced Productivity

Automation has boosted China's manufacturing labor productivity by 6.5% annually, far exceeding the global average of 2.3% (World Bank data).

2. Export Competitiveness

In 2022, machinery and electronic products accounted for 58.6% of China's exports, with intelligent equipment playing a key role (Customs Administration data).

3. Employment Restructuring

While automation reduces demand for low-skilled labor, it has created new roles such as robotics engineers and data analysts. The Ministry of Human Resources predicts 40 million new jobs in smart manufacturing by 2030.

Challenges and Solutions

1. Dependence on Foreign Technologies

Core technologies like high-end industrial software and chips remain import-dependent. In 2021, China's domestic industrial software adoption rate was below 30%.

- Solutions: Increase R&D investment and foster industry-academia collaboration, e.g., Huawei's HarmonyOS in industrial applications.

2. Regional Imbalances

Automation adoption exceeds 60% in eastern coastal regions but remains below 30% in central and western areas.

- Solutions: Promote resource redistribution through national projects like the *East Data West Computing initiative.

3. Environmental and Social Costs

Automation equipment production and recycling may increase carbon emissions, necessitating stricter green manufacturing standards.

Future Outlook

Key trends in China's manufacturing automation include:

- Deep Integration of AI: Baidu's *AI City Brain* optimizes supply chains by predicting demand fluctuations with 92% accuracy.

- Service-Oriented Manufacturing: Haier’s *COSMOPlat* platform offers customized production solutions, serving 200,000 enterprises globally.

- Global Expansion: Under the *Belt and Road Initiative*, China exported $12 billion in smart equipment to ASEAN nations in 2022, including automated port systems and AGVs.

China’s automation strategy balances innovation with sustainability, yet addressing regional disparities and technological gaps remains critical. By fostering academia-industry collaboration and green technologies, China can solidify its position as a global automation leader while mitigating socioeconomic risks.

REFERENCES

1. Butor, L.V. Building the factory of the future through the integration of advanced MES and WMS systems (using the example of Midea Group) / L.V. butor, Taoyuan Zhang// Engineering Economics: Proceedings of the International Scientific and Technical Conference "Engineering Economics", November 27-28, 2024 / Belarusian National Technical University, Faculty of Mechanical Engineering; ed.: K. V. Yakushenko (chairman), A. V. Arabey, S. N. Kovshar [et al.]; compiled by K. N. Shkarovskaya. - Minsk: BNTU, 2024. - P. 62-67.

2. Индустрия искусственного интеллекта в Китае или как зарождался DeepSeek [Electronic resource]. Access mode: https://habr.com/ru/articles/877202/ free.

3. International Federation of Robotics (IFR). World Robotics Report 2023. [Electronic resource]. Access mode: https://ifr.org/ifr-press-releases/news/world-robotics-2023-report-asia-ahead-of-europe-and-the-americas, free.

4. China's imports and exports of 2022 hit a new record. [Electronic resource]. Access mode: https://www.chinadaily.com.cn/a/202301/13/WS63c0bd6fa31057c47eba962e.html, free.

5. National Bureau of Statistics. *China Manufacturing Development Statistical Yearbook (2023) [Electronic resource]. Access mode: https://www.stats.gov.cn/sj/ndsj/2023/indexeh.htm, free.

6.WorldBankDatabase. [Electronic resource]. Access mode: https://data.worldbank.org/indicator/NV.IND.MANF.CD?locations=CN, free.

7. 国际机器人联合会发布2024年机器人五大趋势 [Electronic resource]. Access mode: https://www.chinaagv.com/news/detail/202402/29585.html, free.